FLIGHT and The AIRCRAFT ENGINEER

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The Outlook

A Grand Victory

THE United States Navy, helped, of course, by the aircraft which are part of that Navy, has struck a smashing blow against the Japanese forces off New Guinea. Australians also played a part in the fight, and perhaps before these words are published some details of their part will be made known. Possibly also further details of the damage to the Japanese fleet and transports may be ascertained by air reconnaissance, but undoubtedly the blow to Japan has been a heavy one. The loss of heavy and light cruisers and destroyers will seriously handicap her command of the seas in the south-western Pacific and put a brake on her hitherto uninterrupted advance from island to island. The guns of the American warships and the bombs of their aircraft have played positive havoc with the transports and the troops which were to have landed in New Guinea in preparation for an invasion of Australia. The enemy's loss in men and stores on board those ships must have been very heavy, but the loss of the ships is more serious still. The Allied loss was one aircraft.

America has struck once; she will be able to strike again. The recovery from the Pearl Harbour disaster has begun, and the process will be carried on. The fleet which won this exhilarating victory at New Guinea is undamaged, and it is far from representing the extent of American sea-power. For the future the Japanese will have to send much stronger escorts with their expeditionary forces. They may have to use battleships as escorts, and if they do the Americans will know where the enemy's battleships are.

The command of the Pacific depends on battleships, and none were present at the fight off New Guinea. It may well be that the Japanese do not want to risk their battle fleet in a general action, but prefer to keep it in being, and to conceal its whereabouts from the Americans as long as possible. The far-seeing eyes of the United States carriers will make that more difficult than it once was, for one remembers how the French and Spanish fleets kept Nelson guessing for a long time before they were run down at Trafalgar. But the Pacific is a huge stretch of water in which to play hide-and-seek. The islands of Nippon, however, are fixed, and if the U.S. battle fleet approaches them the Japanese fleet will have to fight in their defence.

Another Supreme Commander

ONCE more we see one officer appointed supreme commander of all forces in an area of war. The first case was that of General Wavell. Now we find General MacArthur made supreme commander of all the Allied forces in the South-west Pacific. This obviously implies that, as in the case of General Wavell, he will control the strategy of all naval and air forces as well as ground troops within his area. This idea of one supreme commander of all forces, regardless of the Service to which he belongs, is obviously to be the rule in the future. It is, so far, the outstanding contribution which this war has made to the strategy of the future. It gives every promise of success. Another example of the same policy is the selection of Admiral Layton as Commander-in-Chief in Ceylon.

Of less significance, but also interesting, is the disregard of the United Nations for the nationality of the officer who is chosen as supreme commander. In the South-west Pacific we have seen first a Briton appointed,

then a Dutchman, and now an American. There is no petty jealousy between the Allies in this matter; the only desideratum is to get the best man for the job. General MacArthur, whose name indicates that he is descended from an ancient clan in the Highlands of Scotland, has aroused the admiration of the world by his epic defence of the Bataan Peninsula in the Philippines against a greatly superior force with command of the sea and superior in the air. Australians will fight under him with enthusiasm and confidence.

Incidentally, the arrival of General MacArthur in Australia is another manifestation of the help which modern aircraft can give in war. The distance of the Philippines from Australia is some 2,000 miles, and it is very doubtful if there is any safe spot on the way for an intermediate landing. But a Catalina or a Liberator could make the distance to Darwin, and, of course, another machine could have brought the General on to Alice Springs, which is a railhead. Only a very few years ago it would have been impossible for the Ceneral to have made such a journey when the enemy held the command of all the seas and most of the islands on the way.

Automaticity

GREAT BRITAIN was the first country in the world to realise the need for relieving the pilot of some of his ever-growing duties. One may instance as an example the introduction of the automatic mixture and boost controls. Other countries followed suit, and now it appears that Germany has tried to go one better in her latest radial engine, the 14-cylinder two-row B.M.W. 801 of some 1,600 h.p. This engine has entirely automatic control, so that the pilot merely operates his throttle lever. The servo mechanism for all the different controls is contained in a separate box at the back of the engine, and is said to contain an amazingly ingenious assortment of "gadgets." The idea sounds very clever, but one wonders whether it is not just possible that there may be too many eggs in that one basket. A single lucky shot might conceivably leave the pilot with a fairly useless throttle lever.

Current Aircraft Problems

DURING the war 1914-18 it was often said that the stimulus of the war advanced flying by ten years. Progress there certainly was, but it was not healthy progress, so that it was not quite true to say that flying advanced as far in the four years of war as it would have done in ten years of peaceful development. The great change was from the pusher with open-girder tail booms to the tractor biplane with fuselage. Apart from that change, the vast increase in performance was almost entirely achieved by using more power.

In this war the picture is very different. It is true that the urge of war requirements is still such that aircraft designers ask for as much power as they can get from the engine designers, but when that demand has been met the aircraft designer is still faced with many other problems. In the last war he was never given more power than he could readily use. In the present that may well happen; indeed, it is happening already in some ways. The airscrew problem, and questions of cooling, require careful study if full use is to be made of the extra "horses" which are becoming available, and the mere piling on of power is not *ipso facto* a guarantee of vastly increased performance. The high-power engine is larger and heavier, requires more fuel and thus a larger aircraft if range and wing loadings are to be kept at reasonable figures.

The problems which confront the designer are numerous and difficult. They are not impossible, but they require time and effort for their satisfactory solution. In this issue we publish the first instalment of an article in which a German engineer outlines the more important of them. At first sight one is inclined to be surprised at the familiarity of them. They might just as well have been stated in a lecture to the Royal Aeronautical Society. But then one remembers that they deal with fundamental questions, which are no respecters of persons or nations.

MIDDLE EAST REPAIRS: Three crashed Hurricanes passing the famous Pyramids at Gizeh, near Cairo, on their way to the repair depot.

War in the Air

Sea Fight off New Guinea: Rhodes Bombed and Shelled: Widespread Air Activity

THE destruction wrought by a fleet of American cruisers and destroyers, assisted by aircraft, some of which seem to have been Australian, on a Japanese invasion convoy off New Guinea may well mark the turn of the tide in the Pacific war. The Japanese lost a number of warships and a still larger number of troop transports and supply vessels, some through well-placed bombs. The loss of the ships will be a severe blow to the Pacific enemy, and the loss of troops and stores may well postpone the threatened invasion of Australia. The whole Japanese strategy has been based on their ability to land troops on any island which suits their purpose, covering the movement with their superior naval strength. Once that naval strength fails them, their whole plan of campaign falls to the ground like a pack of cards.

The gallant General MacArthur has made a great long-distance flight from the Philippines to Australia, where he has been made supreme commander of all the forces of the United Nations. His command extends over the whole South-west Pacific, and includes naval and air forces as well as armies. Considerable numbers of American troops and air squadrons have been arriving in Australia for some time past, though the news has only just been made public. The United States has certainly begun to bestir herself, and she is a giant in strength and resources, though she lacks experience of war. General MacArthur, however, has plenty of experience of fighting the Japanese, and by now knows all the tricks of that trade.

While the battle in Cyrenaica stood still, except for brushes between patrols, the Navy and Air Force made a surprise raid on Rhodes one night.

ATLANTIC COAST WATCH: An oil tanker as seen from a U.S. Navy Blimp on anti-submarine patrol.

CLOSE SUPPORT TRAINING: Lysanders of a Polish army co-operation squadron in formation over the snow-covered hills of Scotland during the recent severe weather.

WAR IN THE AIR

It is a fairly long time since the chief island of the Italian Dodecanese group received any attention from our forces. The enemy were taken off their guard, and the collaboration between the naval bombardment and the R.A.F. bombing worked like a book. The action began by the bombers dropping flares, which caused all eyes, searchlights and guns to point upwards, and then the bombs began to fall. So intent were the enemy on the bombers overhead that when the salvoes of shells from the fleet crashed into the E-boat base and the harbour, where flying boats were believed to be moored, as well as into important targets in the town, the enemy mistook them for more bombs and continued to fire upwards. The fleet laid a smoke screen as it withdrew, and when the guns on the island realised its presence and began to fire at it they had not got the range. A weight of 40,000 lb. of shells was fired by the warships. It was a well-planned operation.

The Russian Front

IN Russia there has been a certain reticence of late in the Russian communiqués. Whenever that has happened before it has usually meant that our Allies are engaged in important operations, and do not intend to say much about them until a definite conclusion has been reached. However, the Moscow correspondent of a Swedish paper has reported that recently Russian parachutists have captured fortified positions behind the German lines in the Smolensk area. Considering how the Russians advertised their parachute troops before the war, surprisingly little has been heard of them since the fighting began. They are, of course, an arm of opportunity, not to be used too often, and only when the situation calls for their special qualities and gives them a good chance of success.

MARSHALL AND GILBERT ISLANDS ATTACK: A U.S. reconnaissance pilot going to report after returning to his ship. Note the bomb hole in the deck received during the action.

Items of news come in from all theatres of the war, all telling of good work, though they contain nothing of decisive importance. In Burma Allied aircraft have made a raid on airfields in the Moulmein area, including the satellites, which, of course, they knew well, and destroyed 25 Japanese aircraft on the ground. The crews naturally survived, but a stroke like that will diminish enemy air activity in Burma for a while.

The Royal Australian Air Force has maintained its regular almost nightly raids on the Japanese at Rabaul, and have damaged an enemy heavy cruiser with a bomb. It is to be hoped that she will not be quickly repaired. On the other hand the Japanese have raided Port Moresby and Darwin again, but they did little damage.

In the Mediterranean Blenheims recently spotted a small convoy, which brought up a congregation of squadrons from various airfields within reach, but the weather prevented them from finding their quarry. But it was spotted again before dusk as it neared Homs, and during the night naval aircraft attacked with torpedoes, first dropping flares to light up the scene. The largest ship was

UNPACIFIC PACIFIC: A scene during the air and sea bombardment of Victje—one of the eight Japanese bases in the Marshall and Gilbert Islands—by the U.S. Navy. The smoke is from oil fuel stores set on fire by the shells and bombs. The aircraft is a Curtiss Seagull, probably catapulted from U.S.S. *Houston*.

WAR IN THE AIR

ENEMY AIR LOSSES TO MARCH 21st.

	Over G.B.	Over Continent	Middle East	Far East
March 15	0	0	1	—
" 16	0	0	0	—
" 17	0	0	1	—
" 18	0	0	1	—
" 19	0	0	2	—
" 20	0	0	3	—
" 21	0	0	17	—
	0	0	25	—

Totals: North 5,684; Middle East, over 3,572; Far East (unofficial), 319.

badly hit. Later the same night another small convoy was spotted and successfully attacked by naval aircraft.

In the English Channel there was a brisk little action with E-boats last week. The enemy attacked a British convoy under naval escort, but the gunboats and a destroyer accounted for half a dozen of the E-boats, though the destroyer, H.M.S. *Vortigern*, was lost. Then the R.A.F. took up the hunt and Spitfires heavily damaged four more.

The Renault factory outside Paris which the R.A.F. bombed is not to be rebuilt. It is said to have been turning out 150 tanks and 600 to 700 lorries a month for the German armies.

BRITISH AIR LOSSES TO MARCH 21st.

	Over G.B. A'crft.	Over Continent A'crft.	Middle East A'crft.	Far East A'crft.
March 15	0	0	1	—
" 16	0	0	0	—
" 17	0	0	1	—
" 18	0	0	1	—
" 19	0	0	5	—
" 20	0	0	3	—
" 21	0	0	5	—
	0	0	16	—

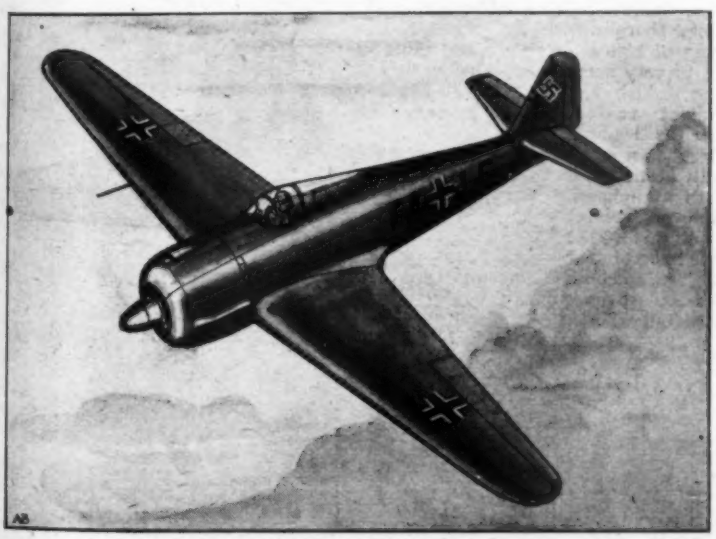
Totals; North, 3,328; Middle East, about 1,021; Far East (unofficial) 37.

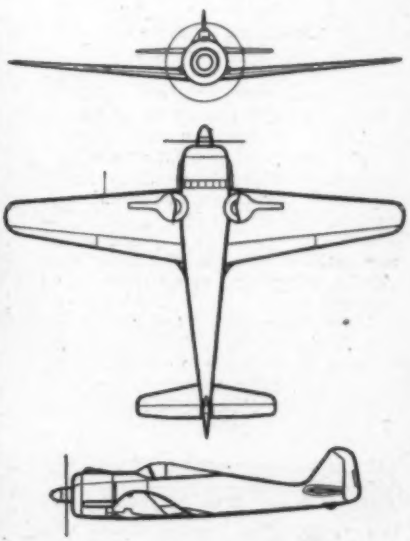
RAID OVER: First and second pilots of a Short Stirling entering the radio compartment on their way to the fuselage exit. The oversize sausage on the cabin wall carries hot air aft to the rear gun turret.

Later News

THE Americans have followed up their successes, and on Friday last four Fortress bombers attacked Rabaul and reported that they had probably sunk one heavy Japanese cruiser and had severely damaged another. Next day Allied aircraft, mostly from the R.A.A.F., attacked grounded machines at Lae, in New Guinea.

Friday was also a busy day at Malta. The enemy raided one airfield all day with great intensity, but the military damage they did was small. Some civilians suffered when German pilots, apparently unnerved by the terrific A.A. fire, dropped their bombs outside the area.





NEW GERMAN FIGHTER. The Focke-Wulf Fw 190, of which this is a drawing made from available data, is the Luftwaffe's latest acquisition. Fitted with a 14-cylinder, two-row radial B.M.W. 801 engine of 1,600 h.p., it constitutes a complete change in German fighter design. Further details on performance and armament are given on p. 285. Although the general arrangement drawings above show an inwardly retracting undercarriage, it is possible that the main landing gear may fold backwards in a similar manner to that of the Master and Tomahawk. Dimensions are: span, 37ft.; length, 28ft. 11in.; wing area, 194 sq. ft.; weight, 7,000 lb.

Thirty-first of the Second Series

FRIEND or FOE?

Two Famous British Trainers : Oxford and Anson

THESE two aircraft are very similar in general appearance from almost any angle, although, actually, the Anson is somewhat the larger machine, especially in overall length. But their respective tail groups provide a quick and certain means of differentiating between them, as is the case with so many otherwise similar designs.

AIRSPEED OXFORD: Pointed apex to fin and rudder. Almost oval tailplane with trailing-edge "bite." Fixed tail wheel.

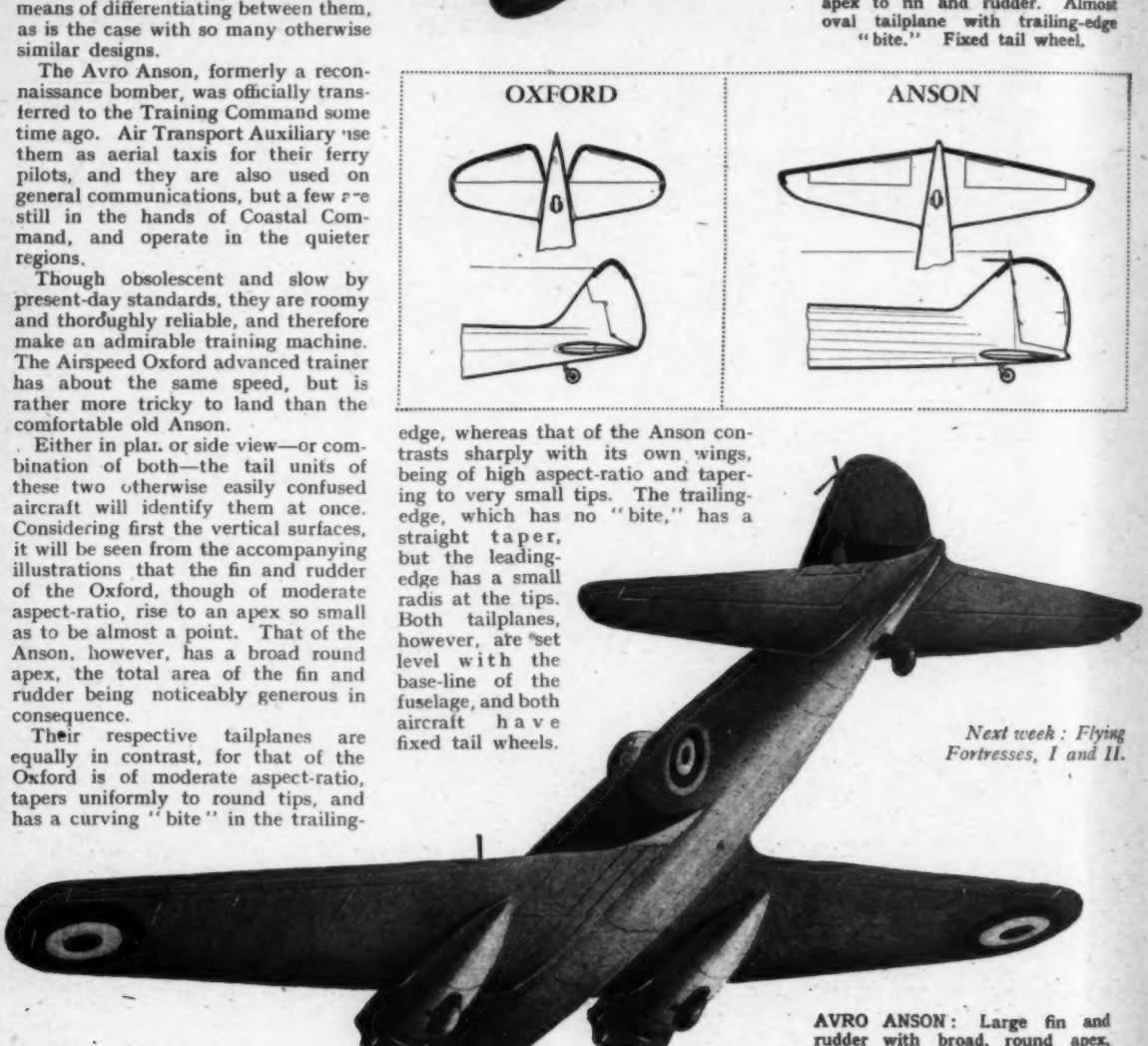
The Avro Anson, formerly a reconnaissance bomber, was officially transferred to the Training Command some time ago. Air Transport Auxiliary use them as aerial taxis for their ferry pilots, and they are also used on general communications, but a few are still in the hands of Coastal Command, and operate in the quieter regions.

Though obsolescent and slow by present-day standards, they are roomy and thoroughly reliable, and therefore make an admirable training machine. The Airspeed Oxford advanced trainer has about the same speed, but is rather more tricky to land than the comfortable old Anson.

Either in plan or side view—or combination of both—the tail units of these two otherwise easily confused aircraft will identify them at once. Considering first the vertical surfaces, it will be seen from the accompanying illustrations that the fin and rudder of the Oxford, though of moderate aspect-ratio, rise to an apex so small as to be almost a point. That of the Anson, however, has a broad round apex, the total area of the fin and rudder being noticeably generous in consequence.

Their respective tailplanes are equally in contrast, for that of the Oxford is of moderate aspect-ratio, tapers uniformly to round tips, and has a curving "bite" in the trailing-edge, whereas that of the Anson contrasts sharply with its own wings, being of high aspect-ratio and tapering to very small tips. The trailing-edge, which has no "bite," has a straight taper, but the leading-edge has a small radis at the tips. Both tailplanes, however, are set level with the base-line of the fuselage, and both aircraft have fixed tail wheels.

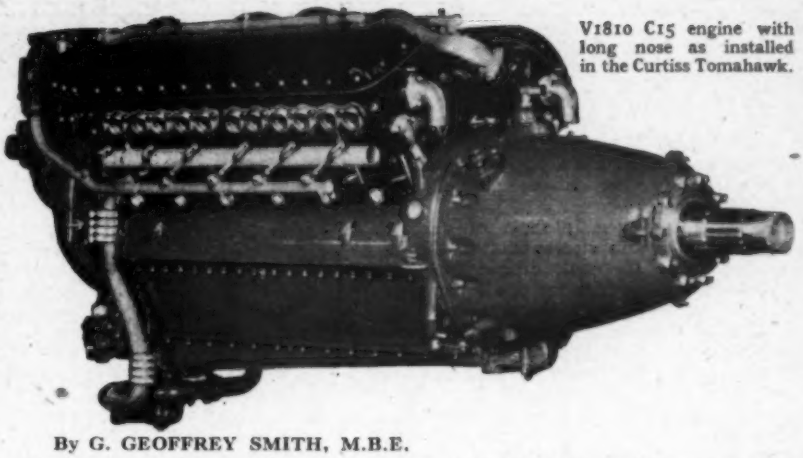
Next week : Flying Fortresses, I and II.



AVRO ANSON: Large fin and rudder with broad, round apex. Wide-span tailplane tapering to very small tips. Fixed tail wheel.

AMERICA'S ALLISON ENGINE

DETAILS OF 12-CYLINDER V-TYPE OF 1,710 CUBIC INCHES CAPACITY. AN ENGINE APPLIED TO MANY U.S.A. TYPES.



V1810 C15 engine with long nose as installed in the Curtiss Tomahawk.

By G. GEOFFREY SMITH, M.B.E.

Previous descriptions in recent issues of "Flight" of leading aircraft engines have appeared on the following dates:

Bristol Hercules	-	*Nov. 27, 1941*
Rolls-Royce Merlin	-	*Feb. 26, 1942*

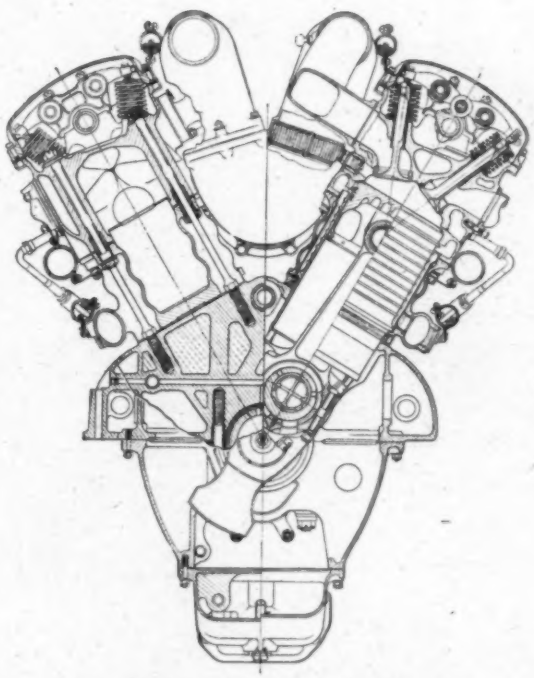
SOME weeks ago an opportunity was afforded by the Ministry of Aircraft Production to examine in detail specimens of the Allison aircraft engine, which now figures in many U.S.A. types in service with the R.A.F. We were able to inspect rows of engines in various stages of assembly at a maintenance repair unit which is now well organised and practised in the overhaul of the Allison, so that servicing proceeds automatically and efficiently.

The Allison is the only example of the liquid-cooled engine in American military aircraft save for the Packard-built Rolls-Royce Merlin. The U.S.A., as is well known, has hitherto specialised upon air-cooled radial engines, which, it must be confessed, have earned an enviable name for dependability and power output.

It is ten years since General Motors Corpn. (which acquired the Allison Engineering Co. in 1929) set about the task of producing a 12-cylinder liquid-cooled V-type engine. Among the attractions set forth by the Chief Engineer, Mr. R. M. Hazen, are (1) small frontal area; (2) the promise of higher power output per c.c. due to the type and uniformity of cooling; (3) greater reliability because it is less sensitive to temporary overloads.

The type best known in this country is the V1710 C15, a designation which indicates the form of the engine and the cylinder capacity in cubic inches. Incidentally, it is 61 cubic inches larger than the Merlin. Fitted to the Curtiss Tomahawk and also early examples of the Lockheed Lightning, the C15 engine differs mainly in appearance from the later E and F types applied to the Bell Airacobra, Mustang and Kittyhawk, in that it has a long nose integral with the crankcase, enclosing the 2:1 reduction gear. This gear is an internal spur gear meshing with the pinion gear splined on the front end of the crankshaft. The E types, on the other hand, are used with an extension shaft and separate reduction gear, as on the Airacobra, whilst the F type on the Mustang, Kittyhawk and Lightning, has an offset spur-type reduction gear. Two models of the F-type engine fitted to the eagerly awaited Lockheed Lightning twin-engined fighters have exhaust-driven turbo superchargers and are rated at 1,000 b.h.p. at 2,600 r.p.m. and 1,150 b.h.p. at 3,000 r.p.m.

It is the C-15 type power unit to which these notes primarily refer, and many entirely original features reveal themselves in a study of this product of one of the great American car manufacturers.



Section through cylinder block of the V1710 type.

General Features

The bore and stroke are 5.5in. x 6in., and the cylinders are cast in two blocks each with six cylinders and set at 60 degrees. The head is a separate one-piece alloy casting, and there are four valves per cylinder, set at 22½ degrees to the cylinder axis, operated by a central overhead camshaft driven by an inclined shaft at the rear of the engine through bevel gears from the accessories drive shaft. The rockers are mounted on the top of the cylinder head. Hardened steel, carburised cylinder barrels are shrunk into the head.

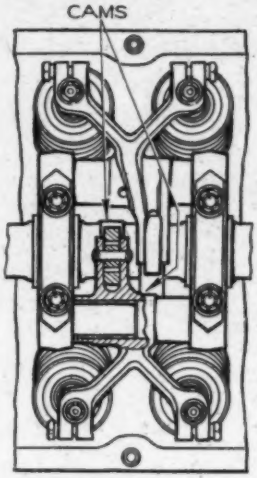
Enclosing the barrels is a jacket of light alloy secured to the head by studs, the lower connection being by a nut threaded on each cylinder barrel. Each block is secured by 14 stud bolts extending through the head, and so clamping the barrels between the head and the crankcase. Sodium-cooled exhaust valves are employed with seats of

D

AMERICA'S ALLISON ENGINE

forged alloy steel faced with Stellite, the valves themselves being of chrome nickel tungsten steel. The inlet valve seats are aluminium bronze alloy and the valves, which have hollow stems, are of low tungsten steel.

A seven-bearing crankshaft of chrome nickel molybdenum steel with the throws counterbalanced is used, carried in plain hollow bearings except for one roller type for No. 7, as shown in the accompanying drawings. Removable light-alloy plugs provide an annular chamber as a passage for lubricant and permitting collection of foreign matter within each crankpin lug. The centre journal is 2⅝in. long, the remainder 1⅛in. by 3⅛in. diameter. At the front end the airscrew reduction gear pinion is splined and the large roller race referred to is interposed between it and No. 6 crank throw. A vibration damper of the dynamic pendulum type is fitted at the rear end to minimise 2-node torsion vibration. At the rear end also is a splined gear wheel driving the spur gear oil pump, cooling pump, fuel pump, vacuum pump and generator. The engine is started through this gear.



The overhead valve gear of one cylinder.

Connecting rods are of I-section and forked. The bearings consist of two steel shells with lead bronze lining for the crankpin journal. There is a lead bronze overlay on the central portion of the outside diameter. The small ends have bronze bushes. Pistons of forged Dural have flat heads with cross ribs inside to facilitate cooling. From the crown downwards there are two plain compression rings and two in one groove for oil control below the gudgeon pin. The pin is fully floating and retained by two circlips.

Two stiffly constructed light-alloy castings with a horizontal joint along the centre line of the shaft form the crankcase. The oil sump, also of light alloy, is bolted to the lower half of the crankcase, and oil is scavenged from both ends.

Lubrication

Oil is circulated by one pressure pump which, with the main scavenge pump, is arranged in unit at the right of the accessory housing. Oil is fed through an Auto-Klean type strainer fitted with a safety by-pass valve opening at a pressure drop exceeding 100 lb./sq. in. From the strainer outlet one large tube in the upper half of the crankcase connects to drilled passages conveying oil to each main bearing.

Journals and crankpins are hollow and interconnected to convey oil to the connecting-rod bearings, from which it is thrown to lubricate the cylinder walls and gudgeon pins. The valve gear is lubricated by oil pressure through the camshaft locating bearing, and flows through the hollow shaft to the eight plain bearings, and thereafter is drained to the crankcase. A second tube in the lower half of the crankcase conveys oil to the large-diameter airscrew shaft plain bearing and the propeller governor pad.

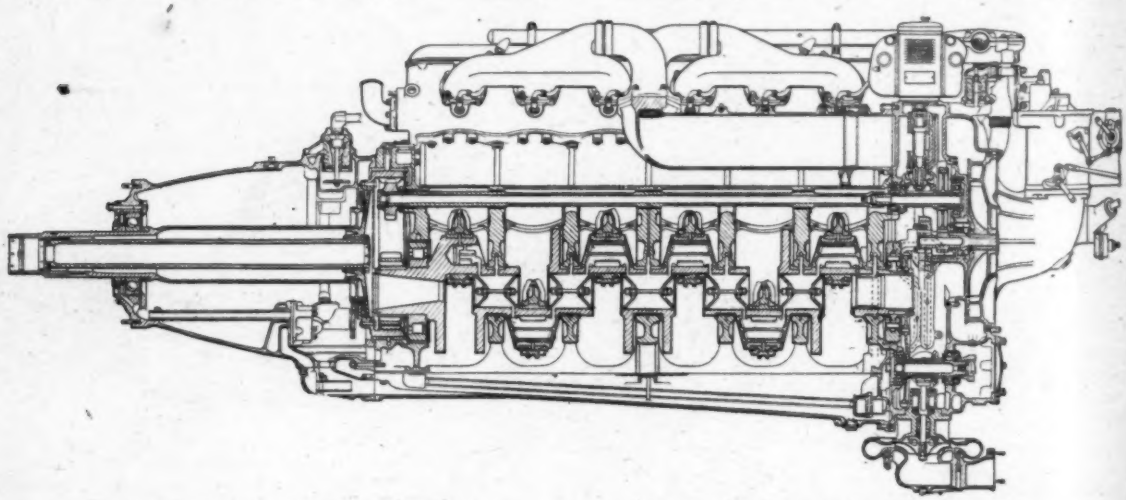
The single-stage single-speed supercharger is combined in the accessory housing. The impellor, of 9½in. diameter, is driven at 8.77 times crankshaft speed, and comprises two parts, one having 15 radial blades, the other 15 curved vanes. These two parts are maintained in their matched relationship by means of common splines on the impellor shafts. The fuel/air mixture flows from the impellor through a diffuser passage having six curved vanes, then through a volute casing or scroll leading to the single delivery duct located between the cylinder blocks. This is continued to the centre of the engine, where it is branched to connect to four manifolds each serving three cylinders.

In the branch feed in each cylinder block a trap is provided to prevent flames from backfire reaching the supercharger. Traps are composed of thin coil strips of alternate flat and corrugated bronze approximately 1in. wide and mounted in a steel frame.

Accessory Drive

The main accessory drive shaft provides flexibility in its 40in. length. It is located directly above the crankshaft in the upper crankcase and supported in four plain bearings. This shaft is driven at twice engine speed from the airscrew shaft reduction gear, and from the opposite end are driven supercharger, camshafts, two tachometers, two distributors, two gun synchronising gears and the magneto.

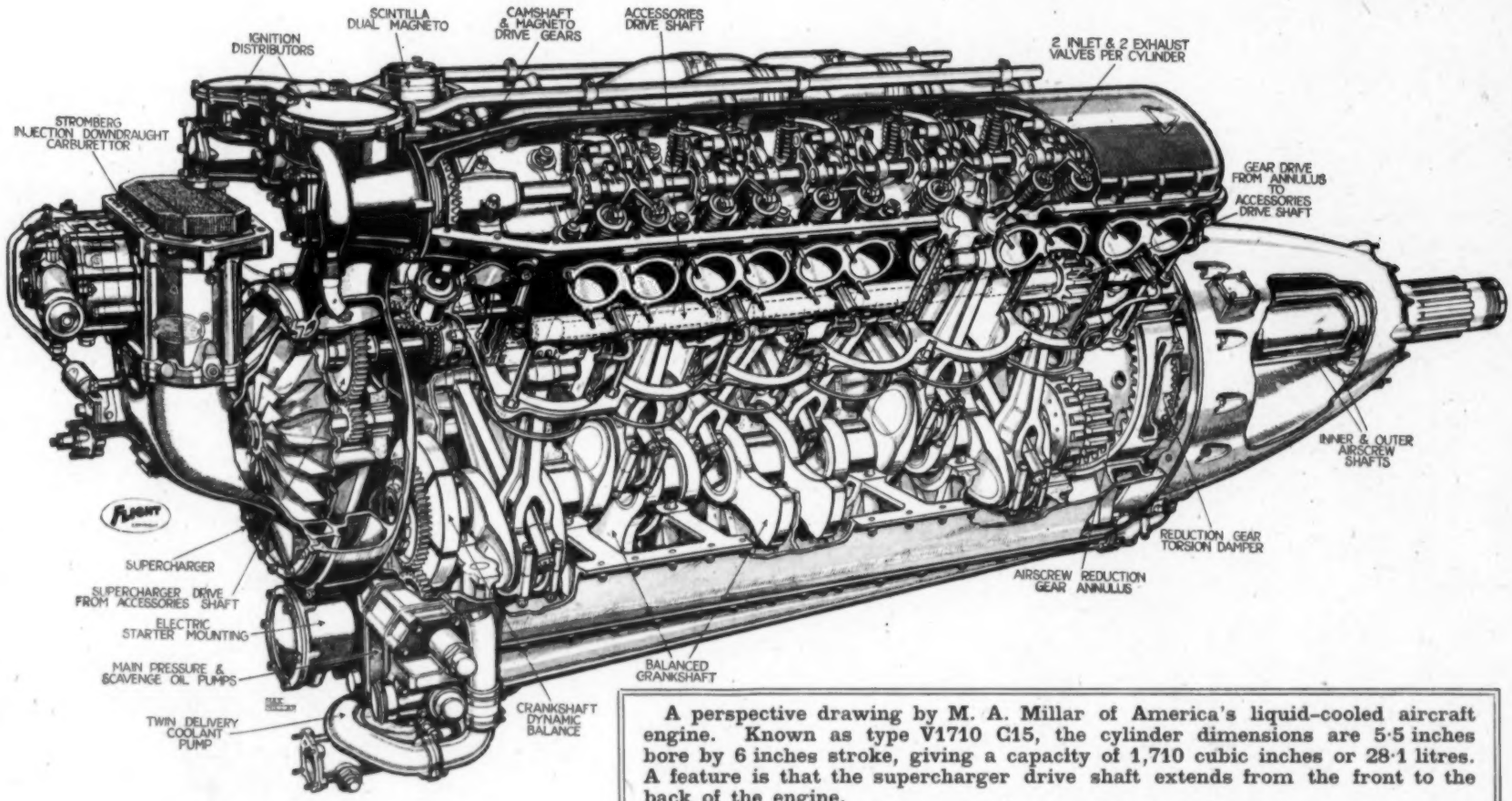
The airscrew governor and the secondary scavenging oil



General arrangement of the long-nose V-type twelve-cylinder Allison engine of 1710 cubic inches capacity.

FLIGHT MARCH 26TH, 1942

THE ALLISON 12-CYLINDER VEE-TYPE ENGINE


IGNITION DISTRIBUTORS
SCINTILLA DUAL MAGNETO
CAMSHAFT & MAGNETO DRIVE GEARS
ACCESSORIES DRIVE SHAFT
2 INLET & 2 EXHAUST VALVES PER CYLINDER
STROMBERG INJECTION DOWNDRAUGHT CARBURETTOR
GEAR DRIVE FROM ANNULUS TO ACCESSORIES DRIVE SHAFT
INNER & OUTER AIRSCREW SHAFTS
REDUCTION GEAR TORSION DAMPER
AIRSCREW REDUCTION GEAR ANNULUS
SUPERCHARGER
SUPERCHARGER DRIVE FROM ACCESSORIES SHAFT
ELECTRIC STARTER MOUNTING
MAIN PRESSURE & SCAVENGE OIL PUMPS
TWIN DELIVERY COOLANT PUMP
BALANCED CRANKSHAFT
CRANKSHAFT DYNAMIC BALANCE

A perspective drawing by M. A. Millar of America's liquid-cooled aircraft engine. Known as type V1710 C15, the cylinder dimensions are 5·5 inches bore by 6 inches stroke, giving a capacity of 1,710 cubic inches or 28·1 litres. A feature is that the supercharger drive shaft extends from the front to the back of the engine.

Maximum power altitude is 1,090 b.h.p. at 13,200ft. at 3,000 r.p.m. Dry weight 1,340 lb. = 1·23 lb. per horse power.

Features are described in the accompanying article.

AMERICA'S ALLISON ENGINE

pump are the only accessories located at the airscrew end of the engine.

Carburation

A single Bendix-Stromberg three-barrel injection type carburettor is employed, which unit comprises throttle body, regulator unit and control unit mounted on top of the accessory housing inlet cover. (For description see *Flight*, September 11th, 1941.) From the control unit a pipe carries fuel to the rear of the supercharger elbow where it is injected from a nozzle directly on to the supercharger impellor.

A centrifugal pump mounted at the base of the accessory housing is connected by pipes to manifolds cast along the cylinder jackets. From the manifolds ethylene-glycol coolant is metered by orifices to each cylinder and individual steel valves direct the flow up each cylinder barrel to the hottest portions of the head.

Ignition is by dual high-tension Scintilla magneto, driven at 1½ times engine speed. This type, DF, has one rotating magnet and two separate and completely enclosed H.T. distributors driven from the rear end of the camshafts. The plugs are diametrically opposed, the timing is fixed and fires the exhaust plugs 6 degrees before the inlet plugs.

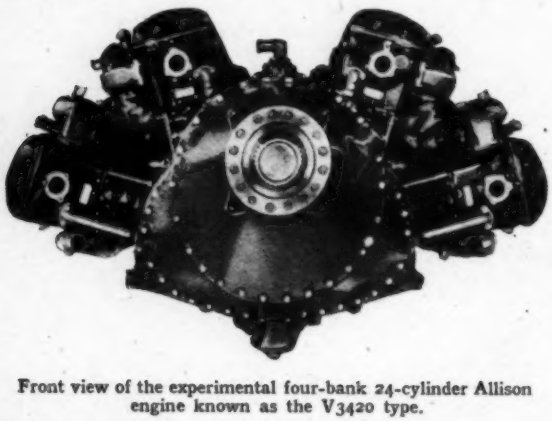
As regards power output, the type described develops 960 b.h.p. at 2,600 r.p.m. at 12,000 feet at the low boost pressure of 2½ lb./sq. in. The maximum power altitude is 1,090 b.h.p. at 13,200 feet at 3,000 r.p.m. and 4½ lb./sq. in. boost, and for take-off 1,040 b.h.p. at 3,000 r.p.m. at sea level with 5½ lb./sq. in. boost using 100 octane fuel.

The boost pressures are quoted approximately on the British system in lb/sq. in. America uses a different method of describing boost pressure, that is, in inches of mercury absolute in the manifold above or below normal atmospheric pressure, which is regarded as 760 mm. or 29.92 in. of mercury.

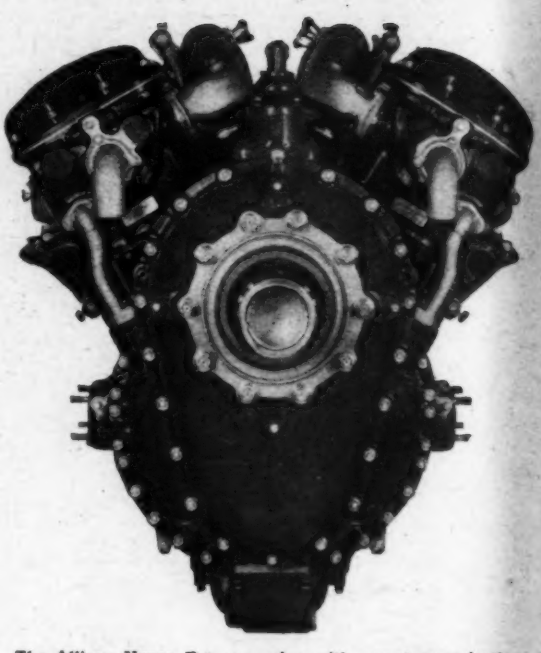
Dry weight without hub or starter is 1,340 lb., i.e. 1.28 lb./h.p.

In Service

The engine is above reproach in finish and workmanship. What weaknesses have manifested themselves have been due to absence of suitable heat treatment on the crankshaft in the early batches reaching this country, which entailed replacements with shafts suitably hardened by the nitriding process. These engines were quickly identified by series numbers and rectifications effected. Maintenance units report that the work of dismantling the engine is noticeably easier than on comparable types save when new liners are necessitated. In this eventuality special tackle is needed to shrink the liners into the head and this represents the most difficult operation encountered and one not possible of execution in the field. The only other component which revealed some weakness was the generator drive, failure of which stops the petrol pump. This also has since been rectified.



Front view of the experimental four-bank 24-cylinder Allison engine known as the V3420 type.



The Allison V1710 F-type engine with spur-type reduction gear.

Recent achievements of the Curtiss Tomahawk and the later Curtiss Kittyhawk single-seater fighters in the Middle East have served to demonstrate the excellence of the Allison power unit with which they are fitted and the important contribution American products are making in air warfare. Soon, no doubt, we shall hear of successes by the Airacobra and other Allison-engined types.

Recent New Developments

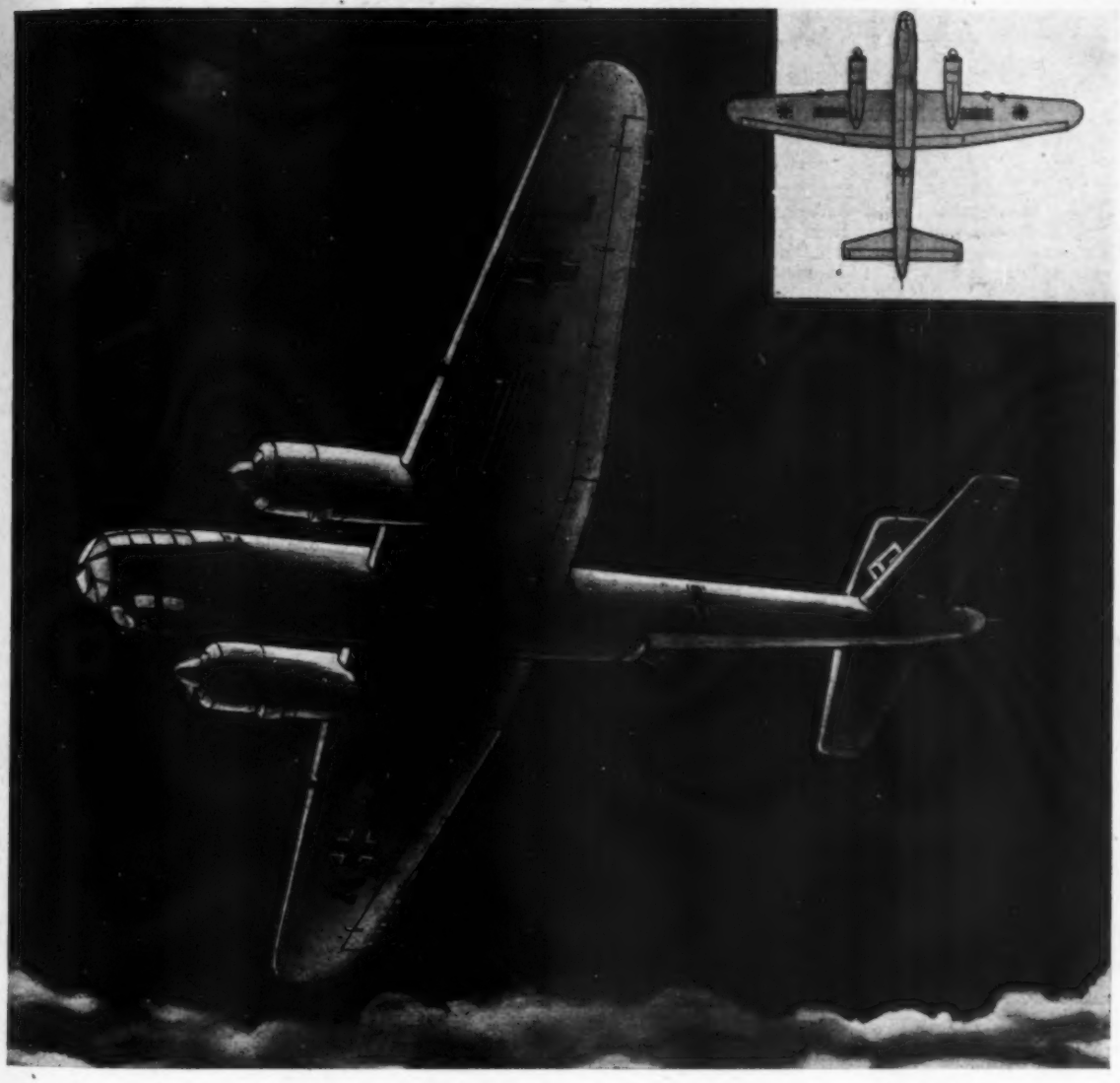
In an address last year Mr. Hazen mentioned that recent improvements, combined with a blower ratio of 6.23:1 and a higher compression ratio of 6.65:1 have, with 87 octane fuel, given a take-off rating of 1,150 b.h.p. at 2,950 r.p.m. He gave the weight of this particular engine as 1,290 lb., i.e. 1.12 lb. per h.p., and in its more developed form it can be revved up to 3,500 r.p.m. in a dive.

Mr. Hazen also briefly discussed the double V engine, type 3420, already referred to in these columns. This new experimental engine of 56.2 litres is a four-bank version of the V1710 and is the subject of one of the illustrations. He said of this large and interesting type: "The crankcase consists of three sections, the centre section separating at the centrelines of the two crankshafts on a 15 deg. angle with the vertical, with the top side narrow. The side cases are made from a single pattern. The bolting-on flanges at each end are identical and are inside the cylinder pad faces, so that through-milling can be employed on all faces.

"The outer bank cylinder decks are parallel to the crankcase parting line, which aids machining and simplifies inspection. Crankshafts have symmetrical flanged ends drilled and reamed to a jig so that driving plate assemblies bolted on determine the direction of rotation. The crankshaft, when turned end for end and rotated in the opposite direction, thus gives the same firing order per bank, so that camshafts and intake manifolds do not have to be changed for either direction or rotation.

"The newer V1710 was kept in mind when designing this power section, and a large measure of interchangeability achieved."

HEINKEL He 177



LUFTWAFFE'S LATEST HEAVY BOMBER: This drawing of the Heinkel He 177 has been built up from such information on its design as is at present available. It has the appearance of being equipped with twin radial engines but this is not so. In actuality each nacelle houses a pair of liquid-cooled in-line engines mounted side-by-side and geared to a common airscrew which may possibly be of the contra rotating type. Circular nose radiators, similar to those of the Ju 88, complete the illusion of radial engines. The fitting of dive-brakes beneath the wings, most unusual on a heavy bomber, is a point of particular interest. The wing-span is 103ft. 4in. and the top speed about 280 m.p.h.

FOCKE-WULF Fw 190

POWERED by the 14-cylinder 1,600 h.p. B.M.W. 801 two-row air-cooled radial engine, the Focke-Wulf 190 single-seater fighter, first reported to be in action over France last autumn, has since been so often encountered by the R.A.F. that it is evidently now in service in considerable numbers. But, as the *Luftwaffe's* latest fighter, it does not seem to constitute a very serious challenge to our own Spitfires and Hurricanes, either in the matter of performance or fire power.

Exact data is not yet obtainable, but the top speed of the Fw 190 is in the region of 370 m.p.h. at 18,000ft., its service ceiling is approximately 38,000ft., and its range at a cruising speed of 300 m.p.h. is just over 500 miles.

Reports from our own pilots who have encountered this machine show that, although it is reasonably quick in manœuvre, our Spitfire is definitely superior in combat and, as regards armament, it is thought to have six machine-guns mounted in the wings—calibre not stated.

An interesting detail is that the air-cooling of the fully cowled engine is fan-assisted.

In appearance (see picture and general arrangement drawings on p. 279) the Fw 190 bears a certain resemblance to the Macchi C 200, but it is not very likely to be mistaken too easily for any of the radial-engined American fighters in service with the R.A.F. and Fleet Air Arm, all of which are distinctly more "tubby" and differ materially in the design of such items as cockpit hood and tail unit.

Ahead of Their Time—2

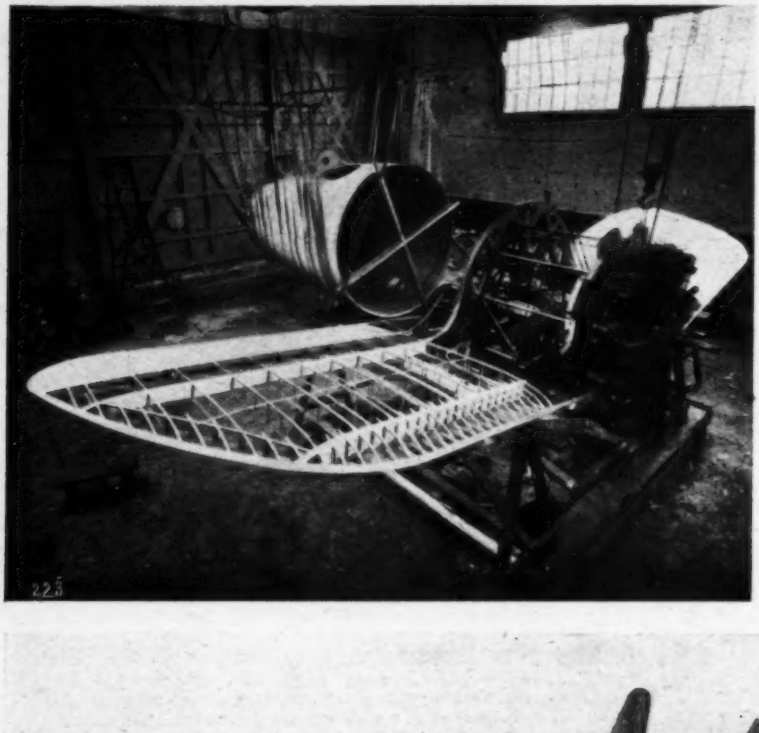
AN OLD-TIME RACER

Early Bristol Monoplane With Many Unorthodox Features : Monocoque Construction : Retractable Undercarriage : Wing-root Fillets : Fully-Cowled Engine

By THE EDITOR

SOMETIME in the 'twenties (1922 I think) the Bristol Aeroplane Company produced a little racing monoplane which few people outside Filton ever saw. I happened upon it by the merest chance one day when walking through the hangars with Capt. Cyril Uwins, Bristol's chief test pilot. My attention was first attracted by something red in a dark corner of the hangar, and although Uwins made polite attempts to steer me past it he did not succeed, and finally I dragged the reason for his reluctance to show me the machine out of him. The little red devil was a racing monoplane into which my very good friend the late Capt. Frank Barnwell had put everything he knew. By that I mean that the monoplane had features which were not only uncommon in those days, but many of which had barely been thought of. That she would have proved fast for her power there is no doubt. I don't think Uwins ever found out, for on his first flight the wings proved too flexible. When he put an aileron down the wing twisted so that instead of rising the wing dropped, and reverse control had to be applied. As Uwins put it, "She stood first on one wing tip and then on the other with me." He managed to land safely by using the rudder only and making his turns very gingerly, but so far as I remember the machine was just put on one side and forgotten. At least I never heard of it taking part in any races.

That was more than a pity, for the little monoplane bristled with ingenious dodges. So much so that I have felt that it deserves a page in the history of British flying, in spite of the fact that, as a racer, it was a failure. Friend Barnwell is gone, and we can-



Several structural features of the Bristol 72 are visible in this picture. Note, for instance, the monocoque fuselage braced internally by a "spider's web," and the bulkheads forming supports for the wing-root fairings.

The small wing span is accentuated by the large-diameter fuselage, and made to look even shorter by the large fillets in the view on the left. The spoked spinner is incomplete as shown.

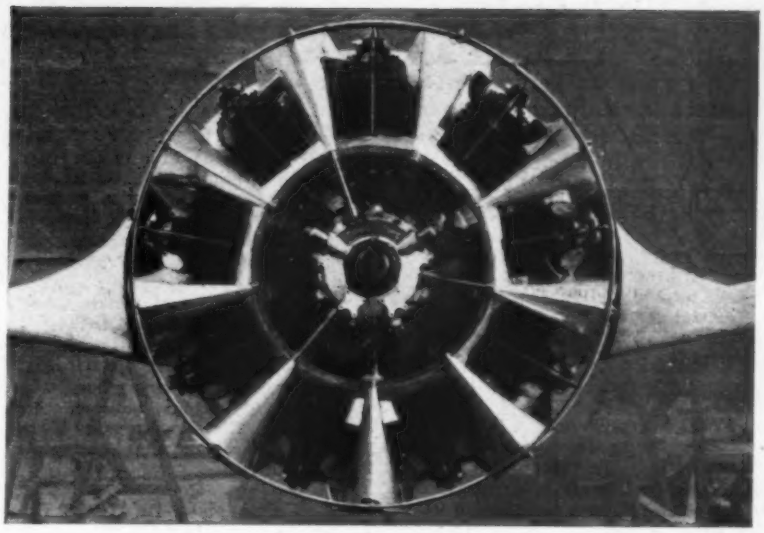
not ask him why a new and stiffer pair of wings was not built. It would have been a fairly simple matter, but then the machine was built during a period when all British aircraft firms were having a hard time of it, and it may well be that the directors did not see the object in spending more money on a type which could, in any case, never become a "bread-and-butter" machine.

Wire Braced

Known in the shops and drawing offices as the type 72 (unofficially it was called other things!), the monoplane was of wood construction, with a wing which, except for its diminutive size, was orthodox enough. The fuselage was a work of art: a monocoque shell (a very thin shell at that) had light former rings internally, much too light to maintain its shape in ordinary handling and therefore braced by a sort of "spider's web" of wires radiating out from central rings. Thus each bulkhead virtually became a bicycle wheel, with the bracing wires as the spokes and the wooden former as the rim.

In 1922 or thereabout we had not done much work on monoplanes with streamline fuselages, and thus little was known about wing-fuselage interference drag. Barnwell must, however, have known that this could be reduced by fillets, and the way in which these were formed in the 72 is shown in a photograph. Multi-ply formers inside the fuselage were shaped on their outer edges to form the basis for upper-surface fillets; at the same time they were the wing roots to which the outer wings were attached.

A thin wing section was used, no doubt with the idea of reducing drag, and the bracing wires ran at a fairly poor angle, which may have had something to do with the wing flexure.



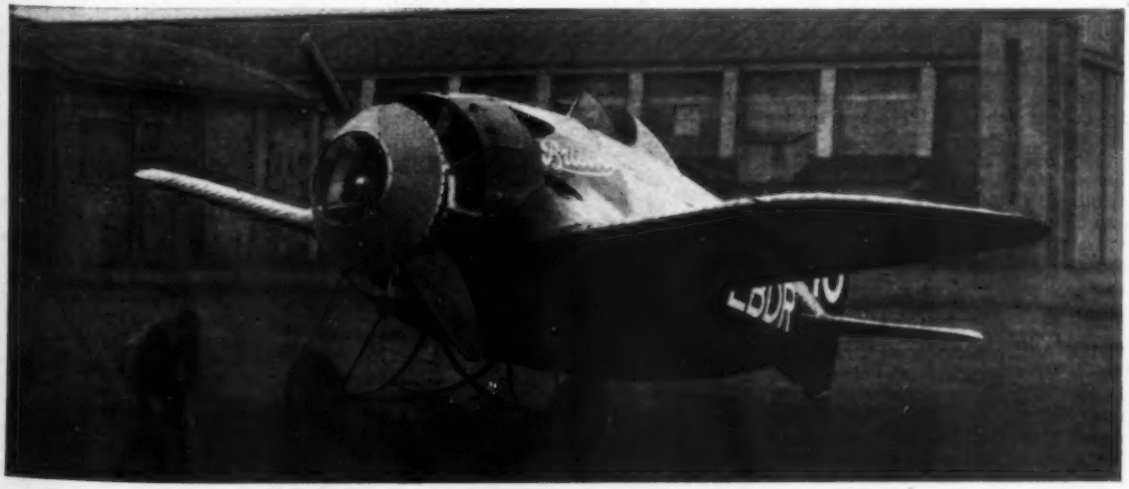
The Jupiter engine of the Bristol 72 had baffles for improved cooling. This was in 1922, before such a system had come into general use.

Ahead of its time was also the retractable undercarriage. The use of a thin wing section precluded retraction into the wing in the manner which has now become common practice. Instead, the axle and radius rods were curved, and when the shock absorber legs were drawn up the tubes disappeared into troughs in the fuselage sides, while the wheel was buried partly in the wing surface and partly in the wing-root fillet. Operation was by hand-operated crank and chains.

The engine fitted was a Bristol Jupiter radial air-cooled, and it is interesting to note that not only was such a "modern" feature as a long-chord cowling fitted, but there were baffle plates between the cylinders to guide the streams of cooling air. The photographs show an unfinished spinner, but in the completed form the engine was totally enclosed. In the spinner, as in the fuselage, extensive use was made of the bicycle wheel type of construction, which must have been extremely light.

Low Weight

I have no weight figures for the Bristol 72, but it was certainly very light. The monocoque fuselage shell and the thin braced wooden wings would not weigh very much, so that probably the main weights were the engine, fuel, undercarriage and pilot. The Jupiter of those days developed about 450 h.p., so there is reason to believe that the calculated top speed of 220 m.p.h. would have been attained.



The good streamline shape of the fuselage was evidently thought more important than small cross-sectional area. The undercarriage retracted, the wheels into the wings and the axles and radius rods into the surface of the fuselage.

BEHIND THE LINES

Service and Industrial News from the Inside of Axis and Enemy-occupied Countries

Luftwaffe Promotions

BY Hitler's special decree the *Luftwaffe* is to enjoy henceforth a number of new "Generalissimos." Taking effect from March 1st, General von Richthofen was promoted to "Col. General"; Lt. Gen. Waber to "General der Flieger," and Maj. Gen. Hoffman von Waldau to "Lt. General."

Messerschmitt 115s in Russia

FIVE Me 115s were shot down by a Russian fighter squadron in a recent action. In the opinion of the Russians, the Me 115, although faster and better armed than the Me 109, has more vulnerable spots. Despite the increased speed, the Me 115 is said to be less efficient in quickness of manœuvre. This, in the view of Russian pilots, explains the German tactics of dealing their blows while diving and avoiding protracted combats.

Ala Littoria

ALTHOUGH Axis propaganda insists that air communications in Europe are developing under the "New Order," the 1941 report of the activities of *Ala Littoria* presents quite a different picture. In place of 40 lines operated in 1939-40 only ten had been active in 1941. This is not only due to general reduction in travel but also to the liquidation of Italy's African Empire.

On the airlines operated, the number of miles flown in 1941 was 68 per cent. lower than that during 1939-40. The number of passengers carried during the period under review is 66 per cent. lower than that in the previous year. This reduction applies also to other branches of the company's activities; as compared with 1939-40 general freight was reduced by 51 per cent., newspaper transport by 60 per cent., and luggage by 63 per cent.

The *Ala*, which in pre-war days was known for its magnanimity in indiscriminately granting reduced fares, has changed its policy; all reductions have been abolished to prop up the meagre revenue of the company, which dropped by 46 per cent.

Air France

THE Vichy Government has cancelled the agreement between the French Government, the *Air France* and the shipping line *Trans-Atlantique*, providing for the formation of the overseas airline *Air France-Trans-Atlantique*. Another agreement between the Government and the shipping line *Chargeurs Réunis*, of March, 1935, for the creation of African Coastal airlines, as well as the 1941 agreement forming the basis for the operation of *Air France*, have been terminated.

The *Air France* is, however, not being liquidated. The company's head offices are scattered between Vichy, Marseilles and Carcassonne. M. Jean Brun (formerly Director of *Lignes Farman*), who was the first to operate in pool with the *Luft Hansa*, is in charge of the Paris office.

A new agreement between *Air France* and the Government is to form the basis of the company's future operations.

A.R.P. Exercises in Denmark

EXTENSIVE A.R.P. exercises are being organised in Denmark during this month. Their objective is to test the quality of equipment and efficiency of the civil defence personnel.

The first exercise took place on March 1st in Köge, in the presence of Gen. Leschly. On the 15th of this month a large-scale civil defence exercise is reported to have taken place in Copenhagen at which some 20,000 members of the police, civil defence and fire brigade participated.

Japan's Torpedo Flyers

IN a widely circulated article, Admiral Tossio Matsunaga, Inspector and Commandant of a Japanese aircraft carrier, gives a few interesting details about the personnel of Japan's Naval Air Arm. Japanese pilots, he said, have only recently succeeded in mastering the technique of landing their aircraft on aircraft carriers. In 1923, when the first Japanese aircraft carrier was commissioned, only one Japanese pilot had accomplished the art. Ever since, this particular manœuvre has presented great difficulties to Japanese pilots, and no fewer than 8,000 take-offs and landings are regarded as necessary to train efficiently a Japanese torpedo flyer.

A strangely sentimental note, inconsistent with the "Samarai behaviour" of the Japs in Shanghai, is struck by the following description: "Before the attack on Pearl Harbour the crews of both the aircraft carriers and the aircraft visited the Shinto Temples and swore either to conquer or not to return. Every officer and man made his will and sent it, together with a lock of his hair, to his family."

Only leaders of detachments of aircraft were informed in detail about the action they were to take and about the weak spots in the defences of Pearl Harbour. Others had only to follow their leader. Torpedoes and bombs dropped on Pearl Harbour, it is claimed, were of special make and of a higher explosive power than those otherwise used. Only specially selected crews took part in the attack on Hawaii and on Malaya.

The attack on the *Prince of Wales* was delivered at low altitude, and the Japanese admiral describes the firepower of the ship as "terrific." The *Prince of Wales*' guns and machine guns fought valiantly despite several torpedo hits, but since there was no aircraft protection the Japanese torpedo flyers could register a better average score than on any previous manœuvre.

Finally, the admiral believes that Japan's Naval Air Arm will play a most important role in the Pacific war.

IDENTIFICATION ON THE BACK: Japanese pilots carry their names and squadron denominations on the back of their flotation jackets.

THE GEISHAS' GIFT: A sound-locator presented to the Japanese Army by the young ladies of Tokyo.

TOPICAL AIRCRAFT PROBLEMS

Performance and Wing Loading : Boundary Layer Control : Direct Fuel Injection : Cooling Difficulties : Turbo-blowers and Ejector Exhaust

By PROF. DR.-ING. GÜNTHER BOCK

THIS article, which is a translation of a paper read before the Lillienthal-Gesellschaft, Berlin, last December, surveys the problems confronting the aircraft designer, and outlines some solutions.

INCREASES in performance and greater availability and reliability are the requirements which, in time of war more than ever, are demanded of flying equipment. Improvements in performance include greater speed, greater height and greater range. Improvements in availability and reliability are directed towards the production of aircraft which shall be ready for use in any sort of weather, and which shall be suitable for the rough handling received in air fighting as well as in operating from difficult landing grounds in the field.

A measure of the progress in the development of performance is afforded by the increase in the flying speed which has taken place between the world-war 1914-18 and the present war. While the maximum speed of fighters at the end of the world-war was about 190 km/hr. (118 m.p.h.), that of to-day far exceeds 600 km/hr. (370 m.p.h.). This increase in performance was brought about by improvements in the aerodynamic efficiency of the aircraft, by the employment of more powerful motors of lower weight and more favourable shape, and by going over to high-altitude flying. The following will examine the roads to further increases in performance which still exist, and how such increases are likely to react on flying qualities and safety.

Aerodynamic Improvement

Let us begin with the possibility of aerodynamic improvement of the airframe. In present-day aircraft approximately 40 per cent. of the total air resistance is governed by the size of the wings. An obvious way, therefore, is to reduce the size of the wings, and thus the wing drag. That way has already been trodden in the past, and. since the world-war wing loadings have gone up from 40 kg/sq. m. (8 lb./sq. ft.) to 200 kg/sq. m. (41 lb./sq. ft.) and more. Very thorough investigations now show that only in exceptional cases can a further increase in wing loading be recommended. In the case of high-altitude aircraft, the highest useful value of wing loading has already been closely approached, since flight in the thinner air at altitude demands greater wing area than flight near the ground. To this must be added the fact that, in addition to maximum speed, climb and manœuvrability are of great importance in the evaluation of the fighting power of an aircraft; and these two qualities are both worsened by extremely high wing loadings.

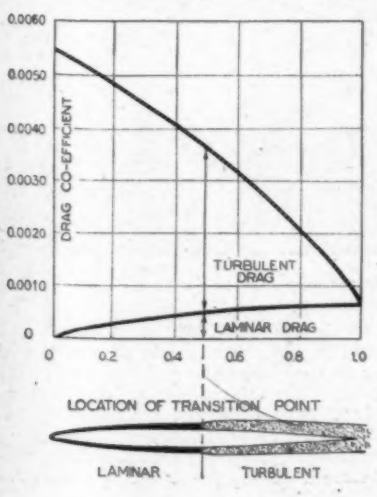


Fig. 1. Drag coefficient for laminar and turbulent boundary layer.

High wing loadings may bring with them high landing speeds. In order to prevent this it is customary to provide the wings with mechanisms which raise the value of the maximum lift coefficient. Among these are all sorts of flaps and auxiliary wings which are adjusted by the pilot before landing. As experiments at the aerodynamic laboratory at Göttingen have shown, the effectiveness of such flaps can be increased by sucking away the boundary layer. This has been confirmed by flight tests.

Work has also been done on reducing drag by improving the wing section. Until a few years ago there seemed to be little possibility of finding a wing section which would give an appreciable drag reduction. In recent years, however, a way has been indicated which appears to promise material progress in this direction.

The Boundary Layer

Wing drag is largely frictional resistance. The air flowing past the wing is so braked by friction that the particles of air in the immediate vicinity of the surface adhere to it, as it were, and only the particles some distance from the surface gradually attain the speed of the free air. The layer in which this speed gradient occurs has been named the boundary layer by Prandtl. It is represented, greatly magnified, in Fig. 1. Over the front portion of the wing section the air has an approximately parallel motion. The flow there is called laminar flow. Then suddenly the flow changes, and the air particles in the boundary layer have a violent movement at right angles to the direction of the main stream, which appears swirling. The turbulent boundary layer has a much greater frictional resistance than the laminar. The total profile drag is, therefore, very largely dependent upon the location of the transition point, i.e., the point at which the laminar boundary layer flow changes into the turbulent flow. In Fig. 1 the transition point has been visualised as moved down the chord of the wing profile. This conception is based upon a wing of very small thickness, which has a chord of 2m. (6ft.), and which travels forwards at a speed of 600 km/hr. (370 m.p.h.) at a height of 6 km. (20,000ft.). If the boundary layer flow were turbulent over the whole chord, so that the transition point coincided with the leading edge, the profile drag coefficient would be 0.0054. If, now, we could succeed in moving the transition point to mid-chord, as shown in the illustration, the drag coefficient would drop to 0.0036; that is, a reduction of 33 per cent. Of this drag the laminar boundary layer would be responsible for 13 per cent. only, while the remaining 87 per cent. would be due to the turbulent boundary layer.

If the boundary layer flow were laminar over the whole chord, i.e., if the transition point lay on the trailing edge, the profile drag coefficient would be only 0.0007; that is, one-eighth of the value for fully turbulent flow. From this it is clear how important it is to get the transition point as far back as possible towards the trailing edge.

Both experimental and theoretical investigations point to a basic connection between transition point and pressure distribution. It will be seen from the pressure distribution shown in Fig. 2 that both on upper and lower surfaces of the profile the transition points lie near the beginning of the pressure gradient. Consequently, if we could succeed in finding wing profiles in which the pressure gradient began as far aft as possible, there would be a

TOPICAL AIRCRAFT PROBLEMS

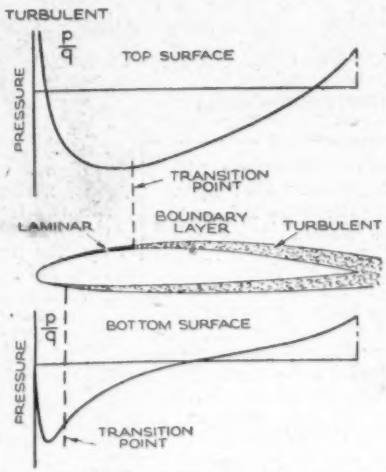


Fig. 2. Laminar and turbulent boundary layer over a wing section. (Lift coefficient $c_a = 0.1$)

good chance of moving the transition point aft also, and thus to reduce the drag. Wind-tunnel tests have confirmed these considerations. Thus we have succeeded in reducing the drag coefficient by choosing suitable wing profiles, without thereby having to sacrifice other qualities of the profile.

In military aircraft it was particularly difficult to achieve favourable aerodynamic fuselage forms. Both for bombing and for defence it was necessary to provide positions which spoilt the form as little as possible. We have, therefore, gone over to cabins with large windows (the German word *Vollsichtkanzel* is amusing—the literal translation being "full-sight pulpit"!—ED.) for the pilot and bomb aimer, both of whom obtain a good view in all directions (Fig. 3). The gunners, too, with their machine guns, are placed in enclosed positions which merge into the lines

Fig. 3. Heinkel He 111 military aircraft.

of the fuselage. A two-gun turret which was used in an elderly type, the Lockheed 14,* is shown in Fig. 4. In order to give the gunner a good field of fire, the entire turret is rotatable about the vertical axis. As the rapid movement of the turret, as well as the elevation of the gun inside the cupola, require considerable power, the turret is hydraulically driven. The control handle, which is operated in a manner similar to that of the aircraft control lever, is clearly seen. The power supply for the hydraulic system is usually an electric motor mounted under the gunner's seat, driving two oil pumps, one for traverse and one for elevation. By operating the control handle the gunner actuates the valves of the two pumps and thus moves the turret about its vertical axis and the gun in elevation.

Increases in Power Output

In addition to the aerodynamic improvement of the aircraft, we have acknowledged as the most important means of performance the increase in motor output. This effort has led, in Germany, to going over from the carburettor engine to the injection engine. On its passage through the carburettor the air is, as is well known, throttled and therefore energy removed. In the injection engine the carburettor is omitted, and the fuel is injected direct into the cylinder on the induction stroke by special pumps which usually lie in the angle between the cylinders (Fig. 5).

The throttling losses of the carburettor therefore disappear, and we obtain, by going over to injection, an increase in power output of 4 to 10 per cent., depending upon the type of carburettor replaced.

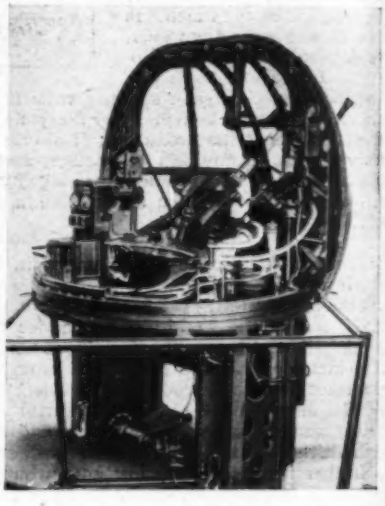


Fig. 4. Servo-operated gun turret on an American aircraft (Lockheed 14).*

A further improvement in output is obtainable on account of the divided feed, each cylinder receiving an even distribution, and the injected quantity of fuel being adjusted to the conditions obtaining at any moment. Furthermore, the injection system offers the possibility of opening the inlet valves before the exhaust valves are closed, thus scavenging the cylinders with fresh air without thereby wasting fuel. As a result of this valve overlap the engine output increases and the tendency to knocking is reduced.

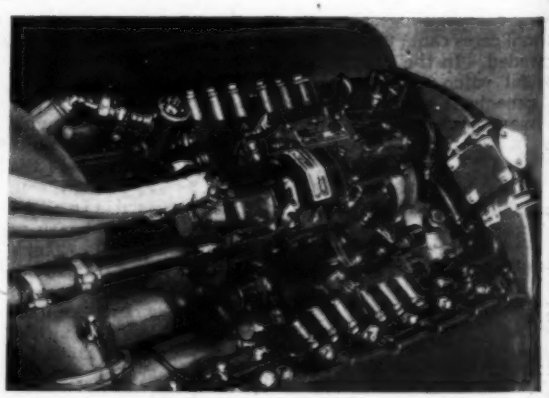


Fig. 5. Injection pumps on Jumo 210G.

The carburettor requires certain qualities of the fuel in order that carburation may be correct under all conditions. As a result, one is limited in one's choice of fuels. It is possible, by the use of suitable fuels, to increase the engine output considerably (see Fig. 6). In some experiments at the D.V.L. on a single-cylinder engine the compression was increased until knocking set in. The mean pressures reached before knocking set in were ascertained.

* The machine is, of course, the Hudson, the 14 being a civil type.—ED.

TOPICAL AIRCRAFT PROBLEMS

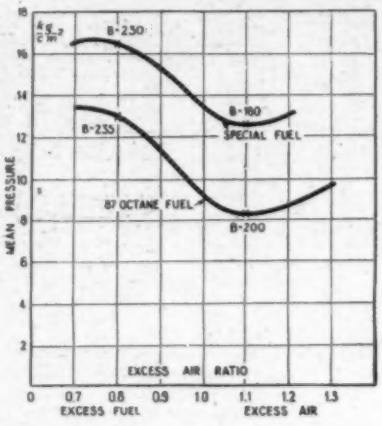


Fig. 6. Attainable mean pressures using special fuels. From experiments with D.V.L. single-cylinder engine. b = fuel consumption in grammes per horse-power per hour with externally-driven blower.

As a further variable was taken the figure for excess air, this being the ratio between the air drawn into the cylinder on an actual induction stroke and the quantity of air which, theoretically, is needed for complete combustion of the quantity of fuel injected. The attainable mean pressure is shown once for normal aviation spirit of 87 octane number and once for a foreign special fuel. The increase in mean pressure by using the special fuel, and the higher compression made possible thereby, represented an improvement of about 40 per cent., and at the same time the specific fuel consumption was reduced.

Yet a further means of increasing engine output may be found in an increase in engine speed. At present limits are imposed on the one hand by the speed at which the air flows through the valves, and on the other hand the control of valve motion becomes more difficult with higher speeds. An endeavour is therefore made to substitute for the type of valve operation hitherto used one which leads to a better filling of the cylinder, and the operation of which does not call for a to-and-fro motion but is achieved by a uniform motion—such as by means of sleeve valves.

The Radiator and Its Installation

The installation of more powerful engines increases the amount of heat which has to be carried away by the radiator. With increase in engine output it is therefore necessary to devote special attention to suitable design and installation of the radiator in order that the greater portion of the extra power shall not be eaten up in overcoming the increased drag of the cooling system. In addition, for altitude flying, coolers for the supercharger air are necessary for getting rid of at least some of the heat generated in the supercharger, thus ensuring knock-free running and a better filling of the cylinder.

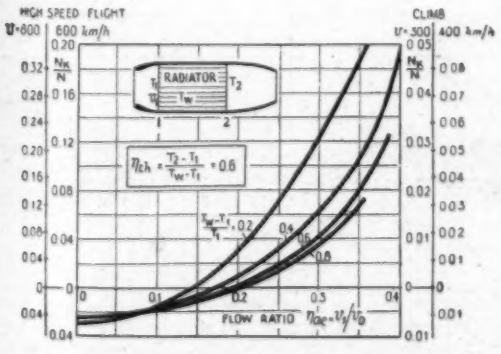


Fig. 7. Drag horse-power required, N_K, of a warm radiator in high-speed flight and on climb, (Internal radiator drag).

The fundamental principle of any cooling system, first appreciated by Professor Junkers, is that the heat transfer of a radiator increases directly as the airspeed, while the drag increases as the square of the speed. For this reason the radiator is to-day always so installed in a cowling that the air flows through the radiator at a speed lower than the air speed. To this end a diffusor is arranged in front of the radiator, as shown diagrammatically in Fig. 7, and behind the radiator there is a cone or nozzle. Obviously, the reduction in air velocity through the radiator thus attained must be compensated by an increase in the size of the radiator.

The air which passes through the radiator is heated and expands. On account of this, it leaves the radiator cowling with greater velocity than it would have in the case of a cold radiator. This increase in speed produces a thrust, as in the case of a rocket. This thrust can become so great that it equals, or even exceeds, the drag which arises from air flowing through the radiator. Fig. 7 gives information on this point.

Radiator Drag

As a measure of the radiator resistance we take the drag horse-power required, N_K, i.e., that part of the engine output which is necessary for overcoming the internal radiator drag. This drag-horse-power is then related to the total power output N. This ratio, N_K/N, is plotted against another ratio, v_1/v_0, which is the ratio between the airflow velocity through the radiator (v_1) and the flying speed of the aircraft (v_0), for horizontal aircraft speeds of 600 km/hr. (373 m.p.h.) and 800 km/hr. (500 m.p.h.), and for climbing speeds of 300 km/hr. (186 m.p.h.) and 400 km/hr. (250 m.p.h.). The ratio v_1/v_0 is denoted in the German test by ηae, and is termed the *Durchflusszahl*, a word which is difficult to translate, but which means

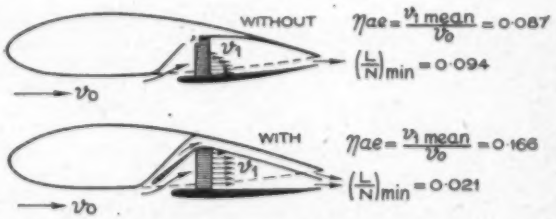


Fig. 8. Radiator without and with "scavenge slot" (*Absaugeschlitz*).

through-flow figure. We have failed to find a short expression for it in English. Flow ratio might serve, but is rather ambiguous.—ED.) As parameter was chosen the excess of the cooling water temperature over that of the cooling air, $\frac{T_W - T_1}{T_1}$. When flying near the ground during the summer this value is about 0.2 for normal water cooling. Then at a climbing speed of 400 km/hr. (250 m.p h.), at which the "flow ratio" might be 0.35, the radiator drag horse-power required would be 9 per cent. of the total engine power. In high-speed flight, on the other hand, the "flow ratio" may be reduced. If it should fall below 0.14 the radiator drag horse-power would become negative, that is to say, the radiator would experience a forward thrust. For values of $\frac{T_W - T_1}{T_1} = 0.8$, which can occur in altitude flight with high-temperature cooling, the radiator drag horse-power required is only 3 per cent. under the same conditions, and the radiator drag changes into thrust at values of the "flow ratio" of under 0.2. It is therefore possible, especially with high-temperature cooling, to reduce the internal drag of the radiator to zero.

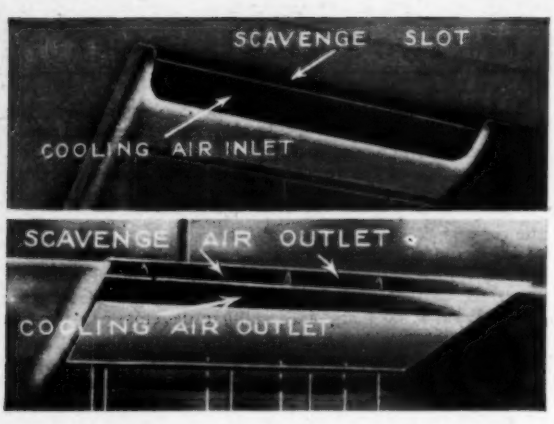


Fig. 9. Radiator with "scavenge slot" used in wind tunnel tests.

In addition to the internal radiator drag there is an external radiator drag caused by the air flowing over the cowling and causing frictional and turbulence losses. In order to keep this drag as low as possible it is customary to transfer the radiator to some other suitable part of the aircraft, such as the wing (see Fig. 8). The wetted area is then but little greater than that of the original wing profile without radiator. However, it is extremely difficult to convey the airflow in front of the radiator into the diffuser as strongly as is necessary with an arrangement of this kind. As a result, there is a tendency for the air in the upper part of the diffuser to break away; this leads to irregular flow through the radiator. It is now possible to avoid this trouble by sucking away the boundary layer before it enters the diffuser. This may be done, as shown in Fig. 8, by a slot-shaped channel between the wing and the radiator cowling, the end of which lies at a point at which there is negative pressure. The effect of this slot on the speed distribution is seen in the increase in the "flow ratio" $v_{i\,min}/v_0$ from 0.087 to 0.166, *i.e.*, almost double. This uniform flow also results in a reduction of drag for equal cooling efficiency. Thus in the wind tunnel tests the drag-horse-power required, L, of the total cooling system amounted to 9.4 per cent. of the total power output, N, in the upper arrangement and only 2.1 per cent. in the lower.

The arrangement of the radiator with "scavenge slot" used in the wind tunnel tests is shown in Fig. 9.

The Altitude Power Plant

In the introductory considerations we have seen that a further increase in speed is attainable by flying at great heights. The attainment of high altitudes is, however, desirable not only to get an increase in speed; it affords bombers and long-range reconnaissance aircraft the possibility of penetrating far into enemy country undisturbed by enemy defence.

The power developed by an aircraft engine drops with increasing height because of the lower air density. To prevent this the engine is provided with a blower which compresses the air, and which is usually driven direct by the engine. The power absorbed by the blower increases considerably with altitude. For example, at a height of 10 km. (33,000ft.) this power amounts to about 30 per cent. of the useful engine power if the blower pressure is to be maintained at 1.3 atmospheres up to that height. The mechanical drive of a supercharger is therefore in many cases uneconomical for great heights. The maintenance of engine power into these regions is, however, conveniently possible by making use of the drop in pressure between the engine exhaust and the surrounding air; this increases with height. Use is made of the exhaust gases by sending them through a turbine driven by the gases. The turbine, in turn, drives the blower (Fig. 10).

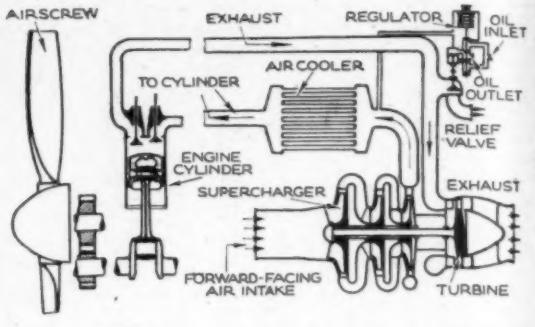


Fig. 10. Diagram of altitude engine with exhaust-driven turbo-blower.

Air enters a three-stage supercharger at the speed of the aircraft, passes through an air cooler in which it gives up some of the heat generated during compression, and finally into the engine cylinders. From the engine cylinders the exhaust gases pass through an exhaust collector into the exhaust gas turbine, in which they give up some of their energy; the remainder is utilised in the form of jet propulsion (ejector exhaust). For the regulation of such an outfit use can, for instance, be made of the pressure of the air behind the blower, which is passed to a regulator that in turn controls a relief valve in the exhaust collector pipe. In this way only sufficient exhaust gas is passed to the turbine for the blower pressure desired.

Utilising the Exhaust Gas Energy in a Turbine

While data for the design of blowers were available from rotary compressor and pump engineering knowledge, the construction of exhaust gas turbines presented special difficulties. The steam turbine could to a certain degree be used as a model, but the temperatures in the exhaust gas turbine are substantially higher than those encountered in the steam turbine; the exhaust gases leave the engine cylinders at temperatures of about 1,000 deg. C., while even in the most modern steam turbines the steam temperature rarely exceeds 500 deg. C. It was, therefore, necessary to learn how to control these high temperatures. The simplest way was so to cool the exhaust gases before they entered the turbine that the temperatures in the turbine did not exceed those permissible with existing materials. This course was followed in America ten years ago. The exhaust pipes were so arranged on their way to the turbine that they were exposed to the air stream. And even the turbine casing and the turbine wheel itself are so cooled.

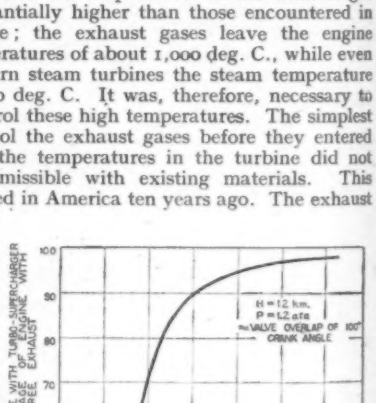
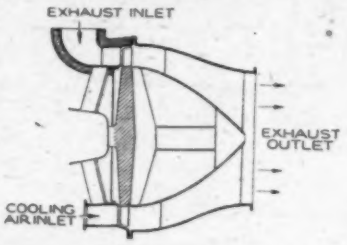


Fig. 11. Filling ratio of engine with exhaust-driven turbo-blower.

However, the reduction in temperature of the exhaust gases in front of the turbine reduces the temperature drop which it is desired to use in the turbine. To produce the necessary blower pressure an increase in gas pressure in front of the turbine is consequently necessary with falling gas temperature. As a result of this rise in pressure in the exhaust pipe, the burnt gases in the cylinder cannot expand so much, so that the filling of the engine with fresh air is made worse. From this it necessaril follows that for a given

PROBLEMS



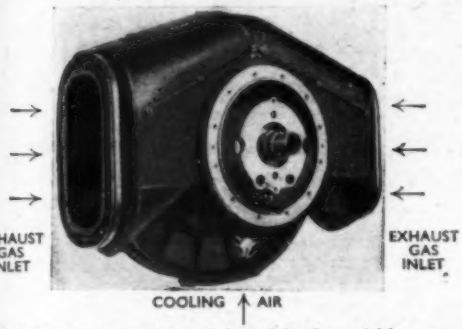


Fig. 12. Cooling a turbo-blower by an air stream over part of the circumference. The diagram is a section of the blower and the lower picture shows an actual turbine built by the D.V.L.

engine there exists, in determining altitude and blower pressure over the required turbine output, a relationship between exhaust gas temperature and filling of the engine which can be estimated by calculation.

In Fig. 11 is shown this relationship for an engine having a 100 deg. crank angle valve overlap, based on experiments and calculations made at the D.V.L.; a blower pressure of 1.2 atmospheres at a height of 12 km. (36,600ft.) was required. The filling of the engine by blower was compared with the filling of the engine with free exhaust, in which the pressure in the exhaust pipe equals the pressure in the free atmosphere. If now one takes into account that the filling of the engine represents a measure of the engine output, it will be seen from this illustration that exhaust gas temperatures under 700 deg. C. result in extraordinary deterioration in engine output, while exhaust gas temperatures of over 900 deg. C. do not promise any material advantages in power output. It is therefore desirable to work with exhaust gas temperatures between 700 deg. C. and 900 deg. C.

Cooling the Turbine

To limit these high temperatures in the turbine, there is the possibility of cooling the turbine wheel itself in a suitable manner. One way of doing this is shown in Fig. 12. The exhaust gases impinge on a portion only of the circumference of the turbine wheel, while another portion of the wheel is cooled by air which can be taken in at the speed of the aircraft. Such an arrangement of a turbo-blower, constructed in the D.V.L., is shown in the lower part of the illustration. The exhaust gases enter into the turbine casing from two sides and flow over a portion only of the circumference of the turbine wheel.

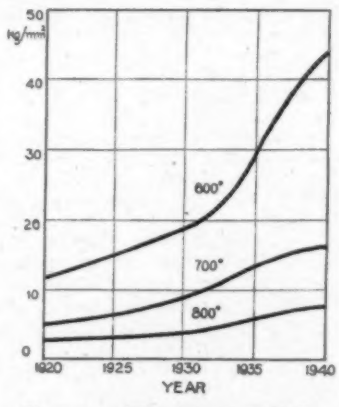


Fig. 13. The improvement in durability of heat-resisting materials since 1920.

The cooling air, on the other hand, is led through a special pipe to the lower part of the casing and flows through the nozzle shown in the lower part of the drawing over the turbine wheel. Exhaust gases and cooling air are ejected together. The remaining energy in the exhaust gases is used in the form of jet propulsion.

Another method of cooling the turbine wheel is to make the blades hollow and forcing cooling air through them. This system, too, has met with success.

The development of the turbo-blower and its associated high temperatures has led to the production of new heat-resisting materials. The progress made in recent years in this direction is considerable. Their development over a number of years for temperatures of 600, 700 and 800 deg. C. is indicated in Fig. 13, which shows how the durability has increased. By durability is here meant the stress at which the material has experienced a certain permanent change of form in a certain unit of time. It will be seen that the durability at a temperature of 600 deg. C. has multiplied 2.4 times in the last ten years; those at 800 deg. C. have doubled. The possibility of using high exhaust gas temperatures has steadily improved.

Utilising Exhaust Gas Efflux

In addition to the turbo-blower there is a further possibility of utilising the energy in the exhaust gases which comes into the foreground of the picture with the increase in flying speed. The exhaust can be passed out through suitable jets when the resulting reaction produces direct thrust (Fig. 14). (This type is known in this country as ejector exhaust.—ED.) The thrust thus obtainable from every horse-power of the engine is then approximately 0.045 kg. irrespective of aircraft speed, and increases with height. Assuming an airscrew efficiency of 75 per cent., the exhaust efflux thrust at ground level represents an increase in engine output of 13 per cent. at 600 km/hr. (373 m.p.h.). At 900 km/hr. (560 m.p.h.) the increase is as high as 20 per cent.

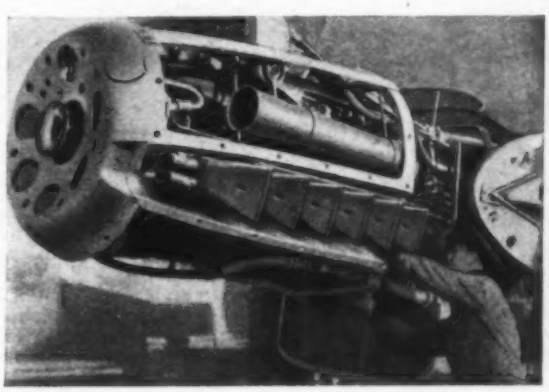


Fig. 14. Ejector exhaust stubs on the D.B.601 engine of a Heinkel He 111.

A proper understanding of the exhaust efflux thrust is therefore very important at high aircraft speed.

The question now arises, when is it appropriate to utilise the exhaust in the turbine and when is it more advantageous to pass the exhaust through jets to get direct thrust? The reply to this question depends largely on the type of power plant installation and on the efficiency of its main parts such as blowers, turbine and jets. As an example, calculations made at the D.V.L. gave the interdependence between thrust and airspeed shown in Fig. 15. The thrust is expressed in hundredths of the output of the naturally aspirated engine. The shaded areas show the engine with mechanically driven blower and ejector exhausts; the black areas refer to the engine with turbo-blower in which the main portion of the energy in the

TOPICAL AIRCRAFT PROBLEMS

exhaust gases is utilised in the turbine and only the remainder utilised for direct jet propulsion. The left diagram refers to a full-pressure height of 6 km., that on the right to a height of 12 km. (36,600ft.). In the case of the engine designed for a full-pressure height of 6 km. the superiority of the turbo-blown engine disappears at air speeds as low as 400 km/hr., while the turbo-blown engine with a full-pressure height of 12 km. is superior up to air speeds of about 900 km/hr. The explanation of this marked influence of altitude is that with increase in height the available temperature drop increases. The temperature drop in the engine with turbo-blower takes place in three stages, viz., the engine cylinder, the exhaust gas turbine and the ejector exhaust. This utilisation is more economical than the two-stage mechanically driven supercharger with ejector exhaust. In fuel consumption also the superiority of the turbo-blown high-altitude engine shows superiority for any speeds that can be expected in any foreseeable time. Furthermore, the regulation of the turbo-blown engine to suit any altitude is almost automatic, since power required by the blower and power developed by the turbine increase similarly with height.

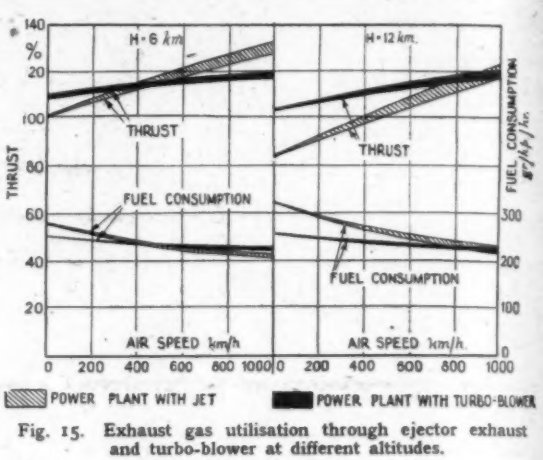


Fig. 15. Exhaust gas utilisation through ejector exhaust and turbo-blower at different altitudes.

High-altitude Engine Accessories

The maintenance of engine power up to great heights is not the only problem set the engine designer by high-altitude flight. The low air density also affects many other parts of the installation. Great altitude brings with it cooling problems, for example. If the engine power is maintained, the quantity of heat which has to be got rid of remains the same. Owing to the lower air density, however, the mass of air flowing through the radiator is lower at altitude. This effect is opposed by the drop in temperature with height, but at great heights the adverse effect of density preponderates, so that altitude flight requires larger radiators. In addition, the permissible temperature of the cooling water drops, because at a height of 12 km. (36,600ft.) water boils at a temperature of 60 deg. C. To mitigate this drawback it is possible to use high-pressure cooling for the whole system. The same precautions may be necessary for the fuel system, since the fuel may, at the low external pressure, begin to evaporate in the tanks or pipe lines, which may lead to an interruption in the fuel supply.

(To be continued next week.)

UNLUCKY WEEK-END

Four Air Disasters : British General Killed in China : Three Women Officers in A.T.A. Crash : Japs Shoot Down Civil Machine

NO fewer than 31 persons lost their lives in four air crashes which happened recently, in China, Western Australia, South Africa and Great Britain, and of these one was the result of enemy action against an unarmed civil air-liner.

Major General Lancelot Dennys, head of the British Military Mission to China, was one of twelve persons killed near Kunming, the Chinese terminus of the Burma Road, when the passenger aircraft in which he was flying crashed in flames shortly after taking off from the airport. Four other British subjects (one, a woman) and three Americans, of whom two were U.S. Army officers, were among the dead, in addition to the two American pilots. Four injured survivors were another American Army officer, a British Government official, and two Chinese passengers. According to an American report, the machine caught fire in the air and the tail broke away.

That accident was on March 14th. Next day two military aircraft collided in mid-air near Kennilworth Racecourse, Capetown; news was received that a K.L.M. air-liner was shot down on March 3rd by Jap fighters near Broome on the coast of Western Australia, and a machine of the Air Transport Auxiliary crashed in bad weather in this country.

In the first of these three disasters, seven members of the South African Air Force, three members of the R.A.F., and two civilians lost their lives; in the second, a woman, a child, and two men perished, and in the third, two women officers of the A.T.A. and the male pilot were killed, a third woman officer being injured. It is also stated that 26 other people were injured in attempting to rescue the pilot and women A.T.A. officers from the wreckage, while in the Capetown crash, eleven civilians were taken to hospital as a result of several houses being set on fire by one of the planes.

Reports from Perth, Western Australia, indicate that the four deaths caused by the attack on the Dutch air-liner occurred when the twelve occupants were machine-gunned and bombed on the ground after a successful landing had been made. The commander of the air-liner was Capt. Ivan Smirnoff, who joined K.L.M. 20 years ago, and although he sustained bullet wounds in both arms and one leg, and his aircraft was set ablaze by the fire from the Japanese fighters, he managed to pull off a safe landing.

Not satisfied with having shot down a perfectly defenceless civilian machine, however, the "gallant" representatives of the Nippon Empire swooped down to machine-gun the stranded passengers and, next day, a Jap flying-boat arrived overhead and dropped five bombs among them. It was during these attacks on the ground that the Dutch co-pilot, the mechanic and a woman passenger and her child received wounds from which they died. The eight survivors were subsequently rescued.

Capt. Smirnoff, who is probably K.L.M.'s oldest pilot, was born in Russia but eventually became a naturalised Dutch subject.

It was he who piloted the Fokker F.18, *Pelikaan*, on the famous Christmas mail flight to Batavia and back in 1933, for which achievement he was decorated.

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

BOMBING POLICY

More Fighter and Attack Planes Needed

I HAVE been reading the interesting discussions which have appeared in recent issues of *Flight* of our bombing policy. At the risk of being dubbed "an armchair critic," I should like to express the view that owing to our land and sea defeats we should now concentrate less on the heavy four-motor bomber and produce more fighters, light attack aircraft and torpedo bombers.

Possibly, if we had been able to clear the air of German fighters over the enemy warships in the Channel on February 12th our torpedo aircraft and also our surface craft could have inflicted heavier damage at their leisure and also with less loss to themselves.

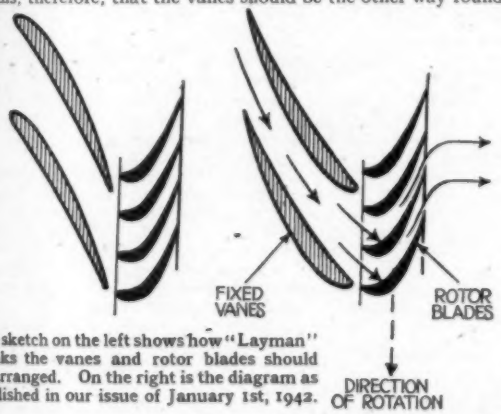
I again read with horror the time-worn phrase, "lack of air support," which has again occurred in the Dutch East Indies. I think it is high time that something was done to remedy this defect. R. J. B.

TURBO-SUPERCHARGING

Arrangement of Fixed Nozzle-vanes

IN *Flight* of January 1st "M. T." shows the principle of the turbo-supercharger. His schematic representation of the turbine nozzle ring vanes and rotor blading seems to have something wrong with it.

The gases passing from the thin end of the vanes to their thicker end would be compressed instead of expanded. It seems, therefore, that the vanes should be the other way round.



The sketch on the left shows how "Layman" thinks the vanes and rotor blades should be arranged. On the right is the diagram as published in our issue of January 1st, 1942.

Also the gases should impinge on the turbine blading as they pass out of the nozzles. The exit of the nozzles should, therefore, be facing the blades at right angles.

In my view the schematic representation should in these circumstances be as shown in the accompanying sketch.

LAYMAN, UNQUALIFIED.

[The writer of the article makes the following observations: "The diagram of the turbine blades given in *Flight* was taken direct from notes by Dr. Sanford Moss, and therefore should be quite correct. As I understand it, the object of the nozzle vanes is to take the exhaust gases as they arrive helter-skelter and marshal them into an orderly troop, so that they fly at the rotor blades and impinge upon them in a uniform manner, and in the direction more or less at right angles to the rotor blades. The shape of the fixed nozzle vanes is such that they tend to increase the velocity towards the exit, like a venturi tube. The vanes shown by 'Layman' curve in the wrong direction for marshalling, and also would tend to reduce velocity instead of increasing it. I have no doubt that the exact shape and disposition of both sets of blades required considerable scientific research; and that the rotor blades are not mere buckets to accept as much as possible of the impact of the gases, but are also little aerofoils or propeller blades extracting maximum energy for minimum interference."—ED.]

LUNAR SPACE VESSEL

Gravitational Loss and Acceleration

YOUR correspondent Mr. Lawrence seems to suggest that in my article on the "Lunar Space Vessel" I had overlooked the effect of gravitational acceleration.

If he refers to my article he will find that I state that "correction must be made for time lost in attaining release velocity, etc."

I consider his addition of a function of gravitation in relation to distance from the centre of the earth, putting an integral sign in front and dt. after, is a poor way of expressing an attempt to integrate grav. loss against time.

He has evidently succeeded in confusing himself, however, because the last question put makes it clear that he does not understand the meaning of his own expression.

A more practical expression of gravitational loss is: grav. loss $= [g_b + \frac{1}{2}(g_a - g_b)]f$, where g_a and g_b are symbols representing gravitational acceleration at a and b respectively, and f = the time interval occupied in uniformly accelerated motion from a to b. The gravitational acceleration at any distance x from the centre of the earth is, of course, $g\frac{r^2}{x^2}$, which term appears in Mr. Lawrence's indigested integral.

This treatment of the loss is very primitive, but is sufficiently accurate to serve the purpose of the "mathematically immature" who may have been led astray by Mr. Lawrence's exhibition of "stunting." R. A. SMITH.

TWO-DIMENSIONAL

More Examples of Film "Howlers"

WITH regard to "Indicator's" article "Two-Dimensional" in *Flight* of March 12th. The majority of films mentioned in this article I have had the pleasure of seeing, and I agree entirely with "Indicator's" criticism on all of them. I was quite surprised to notice, however, that "Indicator" missed out a recent film, which I am sure many aeronautical people saw, and that was "International Squadron."

Those who saw this film will well remember that the planes used were referred to as "Spitfires." This was undoubtedly a wrong statement, as they were more like Percival Mew Gulls. I think "Indicator" will agree that in nearly every flying film, the story means well, but the statements made by the stars are very misleading to an amateur in the aeronautical world.

Another film I remember, not quite so aeronautical, was "Man Hunt." If I remember correctly, at the conclusion of the film, Walter Pidgeon was presumably dropped by parachute from a "Flying Fortress" into Germany. However, the incredible film producers apparently persuaded Walter Pidgeon to bale out of the machine on the port side, which he so marvellously did, although the door of the Flying Fortress is on the starboard side of the fuselage.

I am sure I voice the opinion of many an amateur interested in aviation when I say that films, especially aeronautical, are very misleading in more ways than one. JOHN DARLINGTON.

[The aircraft used in "International Squadron" was a light racing type, with inverted air-cooled engine and externally braced wings, developed in America some time before the war. As our correspondent suggests, it bore a far closer resemblance to the Mew Gull than to any modern fighter.—ED.]

BOMBER ARMAMENT

Cannon Too Big for Turrets

MAY I use some of your valuable space in a reply to Mr. A. S. Robertson's letter published in your issue of March 5th and condemning the gross inadequacy of the armament of .303in. machine guns in the Short Stirling bomber?

I agree with the writer that this calibre of gun is insufficient, though not to a very great extent at present, but when I read his proposal to mount four 20 mm. cannon in each of the three turrets I must conclude that Mr. Robertson has very little knowledge of this gun.

Surely he does not realise the size of the 20 mm. cannon; I

CORRESPONDENCE

have only to remind the readers of *Flight* that the 20 mm. cannon on the Beaufighter extend from well forward in the nose to a position directly underneath the observer's blister, 14-16ft., to give a good idea of the size of Mr. Robertson's proposed turret armament.

Can four such guns be mounted in a modern power-driven turret already well known for its cramped space?

I would like to ask what happened to the American .5in. heavy calibre machine gun, or is this gun still in the process of development? It would strike one as being very near to the ideal armament—that is in numbers—for our heavy bombers.

I seem to remember an article in an aeronautical journal of March, 1939, giving details of a special short-barrelled 20 mm. cannon to be mounted in turrets for the defence of bombers, but, unfortunately, only one such gun could be mounted in a very large turret, the vertical field of fire was small and it was only effective at relatively small ranges.

The answer to Mr. Robertson's second query is that the 37 mm. cannon around which the Airacobra was originally designed was slow firing and has now been superseded by one 20 mm. cannon, which has a far higher rate of fire, two .5in. machine guns on the fuselage and four .3in. machine guns in the wings.

WILLIAM B. RICHARDSON.

MAN VERSUS ALTITUDE

How High Without Oxygen

DR. V. L. GRUBERG ("Man versus Altitude," *Flight*, March 12th) contends that from 9,000ft. to 18,000ft. oxygen must be supplied, with or without CO_2.

I can only say that I have flown many thousands of miles for mere amusement over the Alps and have never troubled about diet or oxygen any more than about a parachute (that destroyer of comfort and careless ease). No ill effects were noticed, though the high-altitude flights often lasted from two to three hours, including passage above the highest peaks in Switzerland.

I know of nothing more pleasant and exhilarating, and used to practise photography under the happiest conditions. My highest altitude was dictated by the ceiling of the machine when not carrying a second passenger. This on one occasion reached about 18,500ft., and very often 15,000ft. as a cruising luxury above the ranges.

Men like myself, accustomed to mountaineering, and of mature age, writes Dr. Gruberg, may have an advantage over young men in adaptability. This view seems to be in accord with fact. My young nephew used not to be allowed to fly above 10,000ft., and my young Swiss ace-instructor of early days used to have to swallow aspirin tabloids on our ascents to ease his headaches!

"VETERAN."

QUITE HABITUAL

What Would the C.S. Unit Do ?

WITH reference to the article by "Indicator" in your issue of March 5th, entitled "Quite Habitual," clarification of a statement made would be greatly appreciated.

"Indicator" states that: "My first diagnosis was that the port c.s. unit had packed up and that the airscrew had gone into its fully coarse position," this being due to engine failure.

Would "Indicator" please state how he knew that the airscrew pitch had changed, and secondly, why *coarse* position? This should surely be *fine* position.

C. D. D.

Effect of "Windmilling" on C.S. Units

SOME of "Indicator's" comments on c.s. airscrews in your issue of March 5th make me think that either I have misunderstood him or he has got his facts wrong.

He tells how, when one engine of a twin he was flying failed, the c.s. unit kept the revolutions of the windmilling airscrew up to very nearly their normal level.

Surely, when an airscrew is windmilling—that is, being driven by the slipstream—the effect of the c.s. unit is exactly the opposite to its normal one. When the revolutions drop the pitch becomes finer and the turning effect of the slipstream is reduced, so that almost immediately after the failure of the engine the airscrew will be in its fully fine position, where the slipstream will have minimum effect, and the revolutions will drop almost to nothing.

I have heard of cases of the converse happening in single-engined aircraft. If the engine cuts with the throttle fully open and the aircraft is then dived steeply—a combination of events that might easily occur in a badly performed loop—the revolutions build up fairly slowly to the figure for which the c.s. unit is set and then increase suddenly and alarmingly. Presumably the airscrew suddenly goes into fully coarse pitch and the slipstream has maximum effect.

GUY H. RAPSON.

ARMY SQUARE PEGS

Transfers to R.A.F. Held Up

SURELY all those men in the Army who have passed the Air Crew Selection Boards of the Air Force are not to be left in the Army to swell the already overcrowded and sorry ranks of square pegs in round holes!

My brother is in the Army and was passed for training as a pilot by an R.A.F. Selection Board. He has given his spare time to study, and is so keen on flying that this latest cancellation of transfers from the Army has made him very bitter.

Is this cancellation of a permanent nature? Has he any chance of getting called, or are we to assume that we are still kidding ourselves that we can still waste extra fit man-power?

I trust someone will find a moment to enlighten me.

"RON."

BOOK REVIEWS

"The Observer's Planisphere of Air Navigational Stars," by Francis Chichester, George Allen and Unwin, 2s. 6d.

THIS planisphere, on stiff card, shows the air navigation stars visible at any time of night or year (weather permitting) to observers in (a) North Europe and central North America, and (b) Southern Australia, New Zealand, South Africa and the Argentine. Instructions for its use are clearly given on the back.

"English for Airmen." By A. R. Moon, M.A. Pitman. 3s.

EXCEPT that it makes use extensively of flying terms and sentences with an aviation flavour in its examples and exercises, this little book provides a study of English for soldiers, sailors and civilians just as well as for airmen. Having dealt with the importance of an extensive vocabulary and the pitfalls of wrongly used words, it goes on to give some helpful advice on note-taking, precis-writing and the sending of messages with stress on the arrangement and presentation of facts.

There is also a chapter on map-reading and, though this is elementary enough for the youngest air cadet, its precise relation to the subject of written and spoken English in this book is a little obscure. Some of the questions in the exercises on map-reading, it must be admitted, are astonishingly elementary; they could be answered in the kindergarten. Apart from this, however, the map-reading section is not without its uses if one includes map symbols in the extension of one's vocabulary.

Aircraft of the Fighting Powers, Vol. 2. Compiled by H. J. Cooper and O. G. Thetford, and edited by D. A. Russell, A.M.I.Mech.E. The Harborough Publishing Co., Ltd. 12s. 6d.

THIS is on exactly the same lines as the deservedly well-received Vol. 1 and provides all essential details of no fewer than 88 types of aircraft employed by 11 different powers. These include 23 of the latest British operational, training and communications types, 20 American, 16 German, nine Italian and six Russian, the balance being made up of five Canadian, two (each) Australian, Iraqi, Jugoslavian and French (Vichy) and a solitary Greek of obsolete British design which was their chief bomber, or torpedo-bomber, when the war spread to the Balkans.

Each aircraft has a page to itself and is accompanied by excellent general arrangement drawings. A compendium of international military aircraft markings with some notes on regulation colour schemes is also included, and the book is a very useful augmentation of the first volume.

HERE AND THERE

From Whitehall to Kingsway

THE Directors of The General Electric Company, Limited, have announced that Capt. the Rt. Hon. David Margesson, P.C., M.C., has joined the Board of the company.

The Liquid-cooled Allison

THE scores of readers of *Flight* who wrote in appreciation of the magnificent perspective drawing by our chief artist, M. A. Millar, of the Rolls-Royce Merlin XX, will be glad to see more of his unequalled work in this issue. The new subject is the Allison C1710 which accompanies a description of this notable engine.

Air Mail to Sweden

THE Postmaster-General has announced that air mail correspondence for Sweden is now being accepted for air transmission. The correspondence should be prepaid at the rate of 1s. 3d. per half-ounce (postcards 7d.) and a blue air mail label should be affixed. The ordinary postal service to Sweden by surface route is still suspended.

Danger from Dirt

DIRT has been defined as "matter in the wrong place," and almost all industrial skin troubles come under this heading.

More than 2,000 cases of industrial dermatitis were compensated under the Workmen's Compensation Act in 1934, and a booklet just issued by Sternol, Ltd., deals with this disease and its causes and suggests at least one preventive.

THE FEMININE TOUCH: British Overseas Airways is employing an increasing number of women in many different departments, including the operations department and on maintenance and repair. The two in this picture are polishing up airscrew parts.

In on the Ground Floor

CANADIAN aviation industry, from a survey made in January, now uses a floor area of over 4,000,000 sq. ft. and employs more than 30,000 persons. Increases in employment and floor area are expected for 1942, with at least one company, National Steel Car Corp., planning to increase its floor area from 350,000 sq. ft. to 750,000 sq. ft. and employees from 3,300 to 8,000.

The largest number of employees on one payroll is that of 8,400 by the three plants of Canadian Car and Foundry Co.

Soviet Air Guards

THE 120 regiment of Soviet fighter planes, which took a gallant part in the battle of Moscow, was re-formed into the 12th fighter plane regiment of guards.

The regiment, which certainly has earned this distinction, has also rendered active help to the infantry in the present Russian offensive: it has destroyed 142 enemy tanks, 11 armoured cars, 1,550 motor cars, 42 guns, 83 anti-aircraft batteries and 46 enemy aircraft.

Air Mail Postcards

THE Postmaster-General announces that, in order to provide a means of communicating cheaply and quickly by air mail with members of H.M. Forces serving in Aden, Burma, Ceylon, India, Iran (Persia) and Iraq, a special air mail postcard service has been introduced with the co-operation of the Service Departments and British Overseas Airways Corporation.

So far as the Royal Navy is concerned the new service will extend to personnel of H.M. Ships and Naval Establishments (including Royal Fleet Auxiliaries and Merchant Navy vessels requisitioned for

PRESSED INTO SERVICE: The military version of the new Douglas C.54, which was originally designed for commercial airline service, about to take off on its maiden flight. It is powered by four 1,350 h.p. engines and has a tricycle undercarriage.

HERE AND THERE

naval or military service whose address is "c/o G.P.O., London") serving on the East Indies Station (including the Persian Gulf and Burma).

As in the case of the corresponding service already available to H.M. Forces serving with the Middle East and East African Forces and in Malta, and to H.M. Ships in the Eastern Mediterranean, the postage rate for the new service is 3d. and transmission is by air all the way to the respective bases.

Thin Ones Only

IN order to secure the most economical use of the aircraft space available, the service is strictly limited to the transmission of thin postcards; the ordinary thin postcard impressed with a 2d. stamp sold at post offices, or any other postcard of similar size and weight, is suitable. In the former case an additional 1d. stamp should be affixed to make up the postage to 3d. and in the latter case postage stamps to the value of 3d. should be affixed. A blue air mail label (obtainable free of charge at any post office) must be affixed in the top left-hand corner of the address part of the postcard, or alternatively the words "By Air Mail" may be written prominently in the same position.

Not by Air Mail!

A CHRISTMAS greeting from the editors and staff of "Interavia," posted in Geneva on December 18th last, reached *Flight* on March 17th.

Leicestershire Loan

CLUB news has been practically non-existent for some time—very naturally—but the Leicestershire Aero Club, many of whose members are flying fiercer jobs than Taylorcraft, these days, has at any rate held its annual general meeting.

Moreover, the meeting achieved something really practical, besides re-electing its various officers from its president, Sir W. Lindsay Everard, downwards. It decided to lend £3,700 of its £3,776 9s. 10d. bank balance to the Government, free of interest, for the duration of the war.

Good show, Leicestershire!

FAMILIARITY BREEDS CONFIDENCE: Potential aircrew personnel at a bomber O.T.U. are grouped into crews and made familiar with the types of aircraft they will fly on operations. Here they are getting on friendly terms with the "despatch department" of a Wellington. The fabric packages visible in the bomb bays are part of the automatically inflating flotation gear.

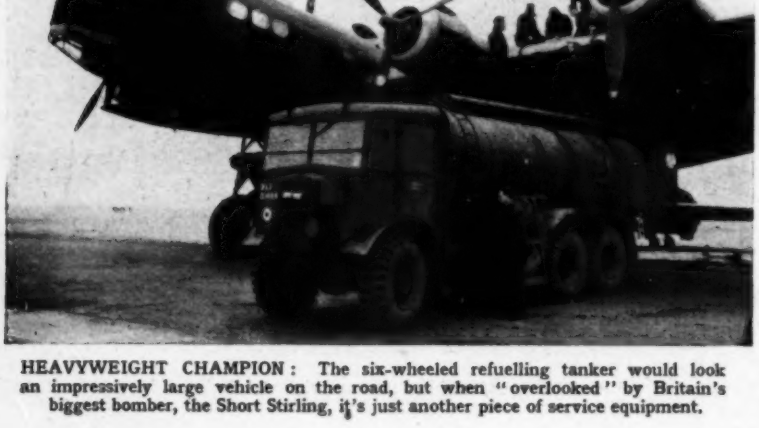
They Have Done it Again!

THE nursing staff of a Sheffield hospital, who topped the list of donations to the British Nurses' Aircraft Fund last year, thus winning the trophy presented by our associated journal, *The Nursing Mirror*, for the highest contribution, have handsomely beaten their own record in the British Nurses' Second Aircraft Fund and, once again, top the list.

The Nursing Mirror recently received a wire from the matron of the hospital—Wadsley Mental and Wharncliffe Emergency Hospital—saying that a cheque for £1,000 was on its way and it duly arrived, the sum being just over double their first contribution and sending the fund's total well above the £5,000 required.

This second fund, incidentally, was started by *The Nursing Mirror* to replace the Defiant night-fighter which was lost, and the excess money over and above the £5,000 is to be handed to the R.A.F. Benevolent Fund in memory of its pilot.

Well done, Sheffield nurses!



HEAVYWEIGHT CHAMPION: The six-wheeled refuelling tanker would look an impressively large vehicle on the road, but when "overlooked" by Britain's biggest bomber, the Short Stirling, it's just another piece of service equipment.

Air Pilots' Guild

HIS Grace the Marquess of Londonderry took the chair at the twelfth annual general meeting of the Guild of Air Pilots and Air Navigators of the British Empire recently held at the Royal Aero Club.

After the annual accounts had been adopted, certain vacancies on the War Emergency Committee, caused by death or resignation, were filled. On review of the general situation, it was felt that the time had not yet arrived for expansion of the Guild's activities, but the Emergency Committee was instructed to keep close watch on this question.

A message was read from the Permanent Grand Master, His Royal Highness the Duke of Kent, in which he commended the value of the Guild's pre-war activities and said that the whole future of civil aviation would have to be recast after the war, and he felt that the Guild would play an extremely important part in enabling the best possible arrangements to be achieved.

Those present at the meeting included Capt. R. H. Henderson, F. C. R. Jaques, G. M. S. Kemp, Flt. Lt. R. J. B. Pearse, Wing Cdr. C. A. Pike, Sqn. Ldr. R. C. Preston, Sqn. Ldr. H. A. Roxburgh and L. A. Wingfield (clerk).

Handley Page Halifaxes in formation. The three pipes at the trailing edge of the wing are for jettisoning fuel in emergency.

Royal Air Force and Fleet Air Arm News and Announcements

Awards

Victoria Cross

THE KING has been graciously pleased to confer the Victoria Cross on the undermentioned officer in recognition of most conspicuous bravery:—

F/O. K. CAMPBELL, R.A.F.V.R. (deceased), No. 22 Sqn.—This officer was the pilot of a Beaufort aircraft of Coastal Command which was detailed to attack an enemy battle cruiser in Brest Harbour at first light on the morning of April 6th, 1941. The aircraft did not return, but it is now known that a torpedo attack was carried out with the utmost daring.

The battle cruiser was secured alongside the wall on the north shore of the harbour, protected by a stone mole bending round it from the west. On rising ground behind the ship stood protective batteries of guns. Other batteries were clustered thickly round the two arms of land which encircle the outer harbour. In this outer harbour near the mole were moored three heavily armed anti-aircraft ships, guarding the battle cruiser. Even if an aircraft succeeded in penetrating these formidable defences, it would be almost impossible, after delivering a low-level attack, to avoid crashing into the rising ground beyond.

This was well known to F/O. Campbell who, despising the heavy odds, went cheerfully and resolutely to the task. He ran the gauntlet of the defences. Coming in almost at sea level, he passed the anti-aircraft ships at less than mast-height in the very mouths of their guns, and skimming over the mole launched a torpedo at point-blank range. The battle cruiser was severely damaged below the water-line and was obliged to return to the dock whence she had come only the day before.

By pressing home his attack at close quarters in the face of a withering fire on a course fraught with extreme peril, F/O. Campbell displayed valour of the highest order.

Fleet Air Arm

THE KING has been graciously pleased to approve the following awards for bravery, skill and daring in air attacks against the enemy:

BAR TO THE DISTINGUISHED SERVICE CROSS.

Lt. M. G. HAWORTH, D.S.C., R.N.

THE DISTINGUISHED SERVICE MEDAL.

Ldg. Airman W. H. BUODEN.

MENTION IN DESPATCHES.

Lt. (E) A. C. S. BLAKE, R.N.
Sub. Lt. A. H. BLACOW, R.N.
Sub. Lt. P. E. BRADSHAW, R.N.
Temp. Sub. Lt. (A) C. R. MALLETT, R.N.V.R.

Royal Air Force

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

BAR TO THE DISTINGUISHED FLYING CROSS.

Flt. Lt. A. E. HILL, D.F.C., R.A.F.V.R.—This officer has carried out many successful operational flights over hostile territory and has shown outstanding skill and determination.

DISTINGUISHED FLYING CROSS.

Flt. Lt. G. F. GRANT, No. 109 Sqn.

Act. Flt. Lt. R. E. ORCHARD, No. 58 Sqn., (deceased), awarded with effect from August 23rd, 1941.

Act. Flt. Lt. P. N. SMITH, R.A.F.V.R., No. 50 Sqn.

F/O. W. PANTON (deceased), awarded with effect from April 20th, 1941.

F/O. A. REECE, No. 109 Sqn.

Flt. Lt. K. T. P. TERRY, No. 42 Sqn.—This officer has carried out 41 sorties against enemy shipping off the Norwegian coast, he has also attacked an enemy airfield at Sola. On one occasion, during a patrol in November, 1941, he observed a convoy in which was a 5,000-ton merchant ship guarded by two escorting vessels. Defying an intense barrage, Flt. Lt. Terry dived to attack and succeeded in scoring a hit on the vessel. Although his aircraft sustained damage which rendered the wireless unserviceable, he flew safely back to his base. This officer has always displayed courage, skill and determination.

Sqn. Ldr. K. Truscott leaving Buckingham Palace after receiving the D.F.C.

Act. Flt. Lt. W. V. CRAWFORD-COMPTON, R.A.F.V.R., No. 485 (N.Z.) Sqn.—This officer has participated in a large number of operational sorties. He has at all times displayed great dash and determination. He has destroyed two and probably destroyed another two enemy aircraft.

Act. Flt. Lt. G. H. FRANCIS, R.N.Z.A.F., No. 485 (N.Z.) Sqn.—This officer has participated in over 50 operational sorties over hostile territory and waters. Throughout he has displayed great skill and determination. He has destroyed at least three enemy aircraft.

P/O. J. C. W. BRUCE, R.A.F.V.R., No. 48 Sqn.—This officer has performed some 340 hours' operational flying, during which he has successfully attacked enemy shipping often in difficult conditions. He has always shown the utmost zeal and determination. Whatever the hazards, his cheerful acceptance of his tasks has set a commendable example.

P/O. E. T. SELLICK, No. 42 Sqn.—One evening in October, 1941, this officer carried out an attack on enemy shipping off the Norwegian coast. Despite heavy defensive fire, he succeeded in torpedoing a medium-sized merchant ship. During the attack his aircraft sustained damage and his observer was wounded in the leg. Nevertheless, P/O. Sellick skilfully flew some 300 miles back to his base in adverse weather conditions and made a safe landing, although his brakes were out of action. This officer has carried out 33 sorties, including a torpedo attack on the *Lutzow*. He has set an admirable example of skill and determination.

Flt. Lt. E. F. K. CAMPLING, No. 142 Squadron.—On February 12th, 1942, this officer participated in an attack on the enemy warships. Whilst making his attack at 700 feet his aircraft was hit by the enemy's opposing fire and sustained damage to the port wing, the elevator trimming tabs and the fuselage. The aircraft became temporarily out of control and dived towards the sea, and when 300 feet from the water it was attacked by two enemy fighters.

The rear gunner was unable to retaliate owing to the damaged hydraulics, but, displaying the greatest skill, Flt. Lt. Campling regained control of his aircraft and evaded the attackers. By flying low over the water he evaded further interception and finally flew safely back to this country, where he made a safe landing. Flt. Lt. Campling has always shown a magnificent fighting spirit which,

SERVICE AVIATION

Hands on the hands down. Physical training on the flight deck of H.M.S. Victorious.

combined with his experience, skill and zeal, has set an inspiring example.

Act. Flt. Lt. C. P. J. WOOD, R.A.F.V.R., No. 403 (R.C.A.F) Squadron—This officer has participated in 31 operational sorties over Northern France, during which he has destroyed three and probably destroyed a further two enemy aircrait. He is a keen and skilful fighter pilot whose leadership and energy have set an inspiring example to his fellow pilots.

P/O. N. W. RICHARDSON, R.A.A.F., No. 12 Squadron.—On February 12th, 1942, P/O. Richardson was detailed to participate in an attack on the German battle cruisers passing through the Straits of Dover. In spite of extremely adverse weather conditions, P/O. Richardson, displaying great perseverance, finally located the objective off the Belgian coast.

Whilst manœuvring to attack the *Gneisenau*, in the face of a terrific barrage, P/O. Richardson was wounded in the arm by a fragment of shell. In spite of this he continued to press home his attack and, diving to 400 feet, he released his bombs, which were observed to fall just in front of the bow of the cruiser. Although his aircraft was again hit by anti-aircraft fire, P/O. Richardson flew his aircraft safely back to his base. Throughout, he set a splendid example of courage and determination.

Sqn. Ldr. L. H. W. PARKIN, R.A.F.O., No. 77 Sqn.—This officer has carried out sorties, including attacks on Wilhelmshaven, Hamburg, Berlin, Ostend and Brest. He is a courageous and determined pilot and captain who invariably presses home his attacks to the utmost. His keenness and cool judgment have produced excellent results.

Act. Sqn. Ldr. G. CLAPPERTON, R.A.F.V.R., No. 78 Sqn.—This officer is a courageous and determined pilot and flight commander. Undeterred by the intensity of enemy opposition, Sq. Ldr. Clapperton has invariably pressed home his attacks with great tenacity. He has carried out attacks on Brest, Bremen, Hanover, Dusseldorf, Stettin and many other enemy targets. Throughout, he has displayed a high standard of operational efficiency.

Act. Sqn. Ldr. F. L. H. EDDISON, No. 214 Sqn. (deceased), awarded with effect from May 9th, 1941.—This officer has always shown the greatest enthusiasm in carrying out all operations against the enemy. His cheerful personality has given great encouragement to less experienced crews on the station. He has set a most excellent example and has afforded the utmost assistance to his unit commander. He has particularly distinguished himself in raids on Brest, Eindhoven airfield and Hamburg.

Act. Sqn. Ldr. P. W. F. LANDALE, R.A.F.V.R., No. 10 Sqn. (deceased), awarded with effect from July 17th, 1941.—By his great courage, skill and personal example Sqn. Ldr. Landale has set a very high standard of airmanship in the squadron. These high qualities did not diminish after receiving injuries in a crash as a result of which he was in hospital for six months. He was one of the most reliable captains in the squadron.

Act. Flt. Lt. R. A. BAILEY, No. 107 Sqn. (deceased), awarded with effect from July 4th, 1941.—In April, 1941, this officer was the navigator of an aircraft which carried out a difficult reconnaissance mission in the face of enemy fighter opposition. This officer also took part in the intensive operations in May-June, 1940, and has participated in attacks against the German fleet. He has proved himself an inspiration to all by his coolness and keenness.

Act. Flt. Lt. R. P. TODD, R.A.F.V.R., No. 101 Sqn.—This officer has taken part in many night sorties, including such long distance targets as Berlin, Turin and Stettin. His aircraft has been badly damaged by enemy anti-aircraft fire on two occasions, but, each time, Flt Lt. Todd, has skilfully made a safe landing at base. He is an excellent captain of aircraft and an outstanding leader whose keenness and devotion to duty have been of a high order.

DISTINGUISHED FLYING MEDAL.

Flt. Sgt. R. C. S. BECK, R.N.Z.A.F., No. 408 (R.C.A.F.) Sqn.

Flt. Sgt. C. L. A. MALLETT, No. 405 (R.C.A.F.) Sqn.

Sgt. R. M. GRAY, A.A.F., No. 115 Sqn. (deceased), awarded with effect from June 11th, 1941.

Sgt. E. J. HOLLAND, R.A.F.V.R., No. 149 Sqn. (deceased), awarded with effect from April 7th, 1941.

Sgt. W. D. HUGHES, R.A.F.V.R., No. 50 Sqn. (deceased), awarded with effect from June, 26th, 1941.

Sgt. C. JENNINGS, No. 114 Sqn. (deceased), awarded with effect from March 31st, 1941.

Sgt. R. E. JONES, No. 97 Sqn.

Sgt. J. W. KYLE, No. 109 Sqn.

Flt. Sgt. D. E. BATTEN, No. 149 Sqn.—This airman has been employed as first wireless operator. Throughout, his trustworthiness, keenness and skill have been highly praiseworthy. One night in August, 1941, he participated in an attack on Hanover. On the return journey his aircraft was twice attacked by enemy fighters. The aircraft was damaged and a member of the crew wounded, but Flt. Sgt. Batten coolly maintained communication with base, obtaining frequent courses, and enabling his captain to fly back to base by the shortest route.

During the journey, in most trying circumstances, Flt. Sgt. Batten kept the base informed of the position of the aircraft, the extent of the damage, and of the well-being of the casualty in the crew. When the aircraft crash-landed, owing to shortage of petrol, this airman remained trapped for half an hour, but he spent the time coolly trying to inform his base of the position. His outstanding ability and behaviour in emergency warrant high praise.

Flt. Sgt. F. W. BROWN, No. 142 Sqn.—This airman has carried out sorties both as second pilot and as captain of aircraft. These sorties have been directed against the majority of important targets in Germany and North-west France, including successful attacks on Berlin and Stettin. Flt. Sgt. Brown has displayed commendable courage and determination, which have won the complete confidence of his crew. One night in August, 1941, on returning from Kiel, his aircraft was attacked by an enemy fighter. Although his aircraft sustained damage, Flt. Sgt. Brown coolly made a safe landing.

Flt. Sgt. E. F. CHANDLER, R.A.F.V.R., No. 82 Sqn.—As wireless operator/air gunner this airman has completed numerous sorties. These have included several low-flying attacks in daylight on shipping and the large-scale attack on Cologne power station in August, 1941. By night he has taken part in attacks on targets in Germany and Northern France. Throughout he has shown praiseworthy determination and keenness.

Flt. Sgt. R. K. HEWITT, No. 101 Sqn.—This airman is a most experienced wireless operator/air-gunner, and he has completed many sorties, including attacks on industrial targets and dockyard installations. On one occasion Flt. Sgt. Hewitt was compelled to abandon his aircraft by parachute, but this in no way diminished his enthusiasm for operations. He has set a splendid example.

Flt. Sgt. M. J. W. SKINNER, No. 58 Sqn.—This airman has carried out the duties of wireless operator-air gunner on operations. He has participated in attacks on the main enemy targets, including Berlin, Wilhelmshaven, Hamburg, Kiel and Brest. Throughout he has displayed great keenness and enthusiasm, whatever the conditions, and he has set and maintained the highest standard in his duties, both in the air and on the ground. His courage and devotion to duty have been most noteworthy.

Sgt. G. COOKE, R.A.F.V.R., No. 106 Sqn.—This airman has captained his aircraft with a high degree of success when operating against such targets as Essen, Cologne, Bremen, Kiel and Brest. His determination is such that after bombing, he has frequently descended to a low altitude in order to machine-gun searchlight positions, gun posts and airfields.

He has bombed Kiel and Huls from low levels in the face of fierce opposition. He took part in two daylight raids over N.W. Germany, during which he displayed great skill and courage in accomplishing low-level bombing and machine-gun attacks. Throughout, this airman has displayed outstanding zeal and initiative.

Sgt. J. K. CORKE, No. 10 Sqn.—This airman has been employed on operations as a navigator. He has proved himself to be extremely competent, remaining unruffled in the face of the most intense opposition. Sgt. Corke participated in the two daylight raids on the *Scharnhorst* and *Gneisenau* in December, 1941.

Sgt. C. CURTIS, No. 408 (R.C.A.F.) Sqn.—As wireless operator-air gunner, this airman has participated in raids against highly defended industrial centres and dockyard installations. These attacks were pressed home with great determination. Recently, Sgt. Curtis attacked a tanker near Emden, and, in spite of heavy opposition, scored a direct hit from a height of only 50 feet. This airman has performed excellent work, and he has played a good part in the successes obtained.

Sgt. I. T. C. EDWARDS, No. 21 Sqn. (deceased).

The Republic P.47 (Thunderbolt) fighter, which is being produced in America for high-altitude work. It is credited with a speed of over 400 m.p.h.

SERVICE AVIATION

Awarded with effect from May 16th, 1941.—This airman has carried out operational raids both by day and by night as a wireless operator-air gunner, including attacks on the German, Norwegian, Dutch, Belgian and French coasts. He could always be relied upon to obtain quick and reliable W/T fixes and homing bearings, and he has displayed the utmost coolness, courage and devotion to duty in the face of enemy opposition. He has shown the greatest enthusiasm to partake in operations against the enemy.

Sgt. B. C. GOODWIN, No. 106 Sqn.—This airman has proved himself to be a wireless operator of considerable technical ability, and when attacking enemy defences and airfields he has never failed to use his guns with good effect. Sgt. Goodwin has participated in raids against most of the highly defended targets. He has shown both courage and opportunism, and he has contributed materially to the successes achieved. He performed particularly good work on two daylight raids when he used his guns on a variety of objectives, including the bombing target itself, gun posts, trains and a ship in the Elbe.

Sgt. L. LITTLEWOOD, No. 408 (R.C.A.F.) Sqn.—This airman has participated in attacks on Mannheim, Frankfurt, Hamburg, Ostend and other important targets. In the course of one operation his aircraft was attacked by two enemy fighters, but Sgt. Littlewood assisted greatly in driving off the attackers. He is a hard-and conscientious worker, and his skill as a wireless operator has contributed materially to the successes achieved.

Sgt. K. MARRIOTT, No. 115 Sqn.—This airman has proved himself an exceptionally keen and courageous wireless operator-air gunner. He has participated in raids against numerous highly defended areas, including Berlin, Wilhelmshaven, Mannheim, Brest, and other targets of importance. On several occasions, during the winter months, he has displayed outstanding ability in trying conditions, thus contributing materially to the safe return of his aircraft. Sgt. Marriott has always shown a keen sense of responsibility combined with great devotion to duty.

Sgt. E. I. NIGHTINGALE, R.A.F.V.R., No. 114 Sqn.—This airman has participated as pilot in attacks on dockyard installations and industrial targets, often in the most difficult weather. One night in January, 1941, whilst attacking the enemy warships at Brest, the propeller of the port engine was sheared off complete with the reduction gear. Despite this, Sgt. Nightingale succeeded in escaping from the target area, and he skilfully flew the aircraft back to a base in this country. Throughout, this airman has shown the greatest determination to make certain of his target before bombing. He has shown skill, courage and devotion to duty.

Sgt. J. RUNNER, R.C.A.F., No. 115 Sqn.—This airman has proved himself to be a cool and courageous air gunner when flying over well-defended areas in difficult conditions. Apart from his duties as rear gunner, Sgt. Runner has always taken a keen interest in map reading and in obtaining intelligent information whilst over enemy territory. On several occasions it has been largely due to his excellent pin-pointing that his crew have been able to identify and bomb their objective. The sorties in which he has participated have included many of the most important targets in Germany and occupied territory.

Sgt. T. N. SANKEY, No. 35 Sqn.—This airman has flown on numerous operational sorties in the role of air gunner. He has participated in three daylight raids, including one against the *Scharnhorst* at La Pallice on July 24th, 1941, when he had seven encounters with enemy aircraft and shot down one and probably destroyed another of them. The second and third raids were against the enemy battleships at Brest. Sgt. Sankey has participated in attacks on the majority of important enemy targets, including Hula, Leuna, Berlin, Hamburg and Gelsenkirchen. Throughout, he has displayed courage, skill and devotion to duty.

Sgt. H. A. WILLIAMS, No. 35 Sqn.—As captain of aircraft, this airman has performed splendid work. He has carried out raids on a wide range of enemy targets, including Stettin, Bremen, Wilhelmshaven, Kiel, Rotterdam, and a long-distance flight to attack a target in Italy. He also took 1941, and on both occasions he displayed unflinching determination regardless of the opposition in two daylight raids on Brest in December, tion. He has set a courageous example.

THE KING has been graciously pleased to approve the following awards in recognition of distinguished services:—

DISTINGUISHED SERVICE ORDER.

Act. Sqn Ldr. W. P. F. TREACY, R.A.F.O. (deceased), awarded with effect from March 27th, 1941.

MILITARY CROSS.

Flt. Lt. J. T. I. SHORE, R.A.F.O.
F/O. B. J. A. RENNIE, R.A.F.V.R.

MILITARY MEDAL.

Sgt. R. W. LONSDALE, R.A.F.V.R.
Sgt. G. ROSKELL.
L.A/C. H. A. MOREMENT.
A/C.1 G. HIBBERT.

HIS MAJESTY has granted unrestricted permission for the wearing of the undermentioned decoration conferred on the officers indicated in recognition of valuable services rendered in connection with the war:—

CROIX DE GUERRE BELGE

Conferred by the Belgian Government.

Act. Wing Cdr. J. RANKIN, D.S.O., D.F.C. and Bar, R.A.F.O.
Act. Sqn. Ldr. G. K. GILAOY, A.A.F.

Roll of Honour

Casualty Communiqué No. 120.

THE Air Ministry regret to announce the following casualties on various dates. The next-of-kin have been informed. Casualties reported "in action" are due to flying operations against the enemy; on "active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

Royal Air Force

KILLED IN ACTION.—F/O. B. A. B. Attwood; Sgt. P. Hankins; F/O. C. A. V. Hawkins; Sgt. V. J. Hopwood; Sgt. W. L. Kelly; Sgt. G. A. Metcalfe; Sgt. F. V. Savy; Act. Sgt. F. W. Smith; Sgt. A. W. Story; P/O. D. O. Weeks; P/O. R. N. Weeks.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. C. Baumber; Sgt. H. R. Chapman; Sgt. K. W. M. Christopher; Sgt. P. F. Collis; Sgt. D. N. Dulley; Sgt. R. A. Dundon; Sqn. Ldr. P. F. Edinger; Sgt. M. Guest; Sgt. A. Hendy; Sgt. R. G. Hill; Sgt. G. Lightley; W/O. D. J. Pitcher; Act. Flt. Lt. M. E. Potier; Sgt. T. P. A. Riddell; Sgt. R. B. Russell; Sgt. W. E. Stayte; P/O. I. M. Strachan; Sgt. A. F. Suckling; Sgt. S. A. Symons; Sgt. P. A. Truman; Sgt. W. White; Sgt. J. H. Wilson; Sgt. W. P. Wright.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. E. W. Aires; Sgt. H. Aldridge; Sgt. T. Appleby; Sgt. G. J. Beckwith; Flt. Sgt. R. R. Bell; P/O. J. F. Bendix; Sgt. H. Black; P/O. J. C. Broadhurst; Sgt. R. S. Bryer; Flt. Lt. N. K. Burton-Chadwick; Sgt. A. J. Casey; Sgt. L. T. Chapman; Flt. Sgt. W. E. Chappell; Sgt. H. J. Clarke; Sgt. W. H. Cole; Sgt. H. Colling; Flt. Sgt. K. Coney; Sgt. G. A. Cowell; Act. Wing Cdr. G. L. Cruickshanks; Act. Sqn. Ldr. W. Davies; Sgt. J. D. Duthie; P/O. E. E. Ellner; F/O. W. Esplen; Act. Flt. Lt. K. J. Falconer, D.F.C.; Act. Flt. Lt. J. O. W. K. Ferris; Flt. Sgt. J. M. T. Fisher; Sgt. W. Fisher; P/O. R. U. Gee; Sgt. C. W. Hancock; Sgt. H. R. Heighton; P/O. A. J. Henderson; Flt. Sgt. A. G. Hole; Sgt. J. J. Jordan; Sgt. A. N. Kennedy; Act. Flt. Lt. T. F. Kerr; F/O. R. G. Lauder; P/O. H. Law; P/O. S. J. Leach; Sgt. J. D. Life; Flt. Sgt. O. R. Lucas; Flt. Sgt. W. D. McAdam; Sgt. H. Mann; Flt. Sgt. T. R. Marshall; Sgt. K. B. Minty; P/O. M. S. Nicholls; Sgt. P. F. B. Orwin; Sgt. A. N. Page; Sgt. J. Plant; Flt. Lt. C. R. McL. Petley; Sgt. C. D. Phillips; Sgt. E. W. Pollard; Flt. Sgt. J. R. Powell; Flt. Lt. F. C. Powles, D.F.C.; Act. Sqn. Ldr. D. H. Seale; Sgt. E. C. Shea; Sgt. L. W. Shearing; Sgt. P. D. Simpson; Sgt. D. C. Smallbone; Sgt. D. H. Smith; Sgt. J. F. Smith; Sgt. R. Spencer; P/O. B. W. B. Squires; Sgt. A. G. Tatham; Sgt. B. R. Thomas; Flt. Sgt. R. H. Thompson; Sgt. H. B. Turner; Flt. Lt. A. W. K. Watson; Sgt. P. E. Whiting; Flt. Sgt. S. J. Williams; Sgt. A. Windle; Sgt. D. F. Youldon.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION NOW REPORTED KILLED IN ACTION.—Sgt. R. R. Hall.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. D. W. Pike.

WOUNDED OR INJURED IN ACTION.—Sgt. L. R. Foulkes; Sgt. S. J. Rout; Sgt. E. R. Vagg.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. R. Anyan; Sgt. A. J. Dickerson; Sgt. A. P. Everett; Flt. Lt. J. D. Fletcher; Sgt. S. G. Harding; Sgt. D. E. Hodgkinson; Sgt. H. J. McDowall; Act. Wing Cdr. R. D. R. Macladden; P/O. R. V. Selfe; Flt. Lt. A. J. Smith; Sqn. Ldr. M. T. Stephens, D.F.C.; P/O. J. Wood; Sgt. R. McK. Young.

MISSING.—P/O. G. Allen; P/O. F. C. Ashley; Sgt. M. J. F. Baldwin; Sgt. D. L. Bennett; Sgt. T. Birthwhistle; Sgt. J. E. Bond; Sgt. L. P. Bow; F/O. N. Bowker; P/O. P. C. L. Brunton; P/O. D. J. Clement; Sgt. R. C. W. De Courcy; Sgt. J. Denham; Sgt. C. C. Duce; Sgt. A. Fulton; Sgt. A. Gibson; Sgt. H. E. Graham; Sgt. R. Holt; A/C.1 H. T. How; P/O. A. J. Jones; P/O. J. T. W. Kelly; P/O. M. M. Khan; Flt. Lt. W. J. W. Kingston; Sgt. V. T. Lewis; Flt. Sgt. N. McClean; Sgt. R. S. A. McLarty; Sgt. D. MacMillan; Act. Flt. Lt. W. St.C. McNeilly, D.F.C.; Sgt. C. W. C. Micklethwaite; P/O. G. K. T. Milne; W/O. R. J. Ommaney; Flt. Sgt. E. R. Penhale; Sgt. L. L. Phillips; Sgt. G. E. Probert; Sgt. A. W. Rolfe; Sgt. R. R. Rowell; Wing Cdr. W. R. Selkirk; P/O. K. J. E. Smethurst; L.A/C. A. V. Smith; Sgt. R. F. Thompson; Sgt. R. N. Thompson; Sgt. J. A. Tobin; Sgt. R. W. Turnbull; Flt. Lt. D. F. Walker; P/O. M. Woodhouse.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. A. W. Lavender; Sgt. N. Ranganatha.

KILLED ON ACTIVE SERVICE.—L.A/C. A. R. Atkins; L.A/C. W. A. T. Beeton; P/O. E. J. Campbell; P/O. K. H. Cockeroft; Sgt. J. Corrie; L.A/C. M. Crowther; P/O. M. V. D. D. Devereux; P/O. L. W. C. Gregory; L.A/C. C. Q. F. Hartley; Wing Cdr. W. S. Jenkins; L.A/C. J. W. Leach; A/C.1 J. Sherwood; P/O. P. L. Southill; P/O. C. R. T. Stockings; P/O. E. S. G. Sweeting; A/C.1 C. Thomas; P/O. W. A. Walsh; Sgt. J. Westwood.

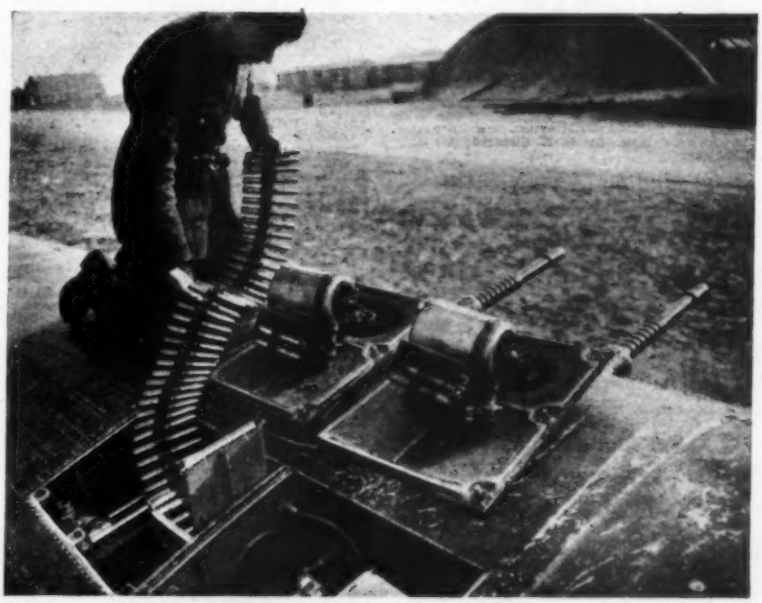
PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Act. Sqn. Ldr. S. L. Portass; L.A/C. P. W. H. Short; Cpl. R. H. R. Wrighton.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Act. Flt. Lt. A. G. Douglas; A/C.2 A. J. Smith.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. L. E. G. Buck; Flt. Lt. P. F. Mayhew.

DIED ON ACTIVE SERVICE.—Sgt. R. E. Cowie; A/C.2 W. Hawthorne; L.A/C. J. C. Holloway; A/C.2 J. R. Lambert; Cpl. N. A. Saunders; A/C.2 E. Stephenson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED



Re-arming the two 20 mm. cannons in the port wing of a Hurricane II.

SERVICE

PRISONER OF WAR.—F/O. J. N. G. Bateman; P/O. S. Beckett; Sgt. P. A. Greig; L.A/C. L. D. Llewellyn; Flt. Lt. E. G. L. Pelling; L.A/C. E. W. Walker; Sgt. G. Wiscombe.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—A/CW.2 M. Jones; Cpl. H. P. Martin; A/CW.2 J. D. Wright.

Royal Australian Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. K. J. Miller; P/O. E. J. Sugg.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. D. R. Gale; Sgt. E. V. K. Higgins; Sgt. N. B. Wilson; Sgt. J. W. Turner.

WOUNDED OR INJURED IN ACTION.—F/O. T. O. Briggs.

MISSING.—Sgt. H. C. Kerr; P/O. F. J. Workman.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—P/O. A. L. Baker; P/O. F. R. O'Neill.

KILLED ON ACTIVE SERVICE.—Sgt. E. M. Hyde.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—P/O. E. W. McLeod.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—F/O. H. G. H. Roberts.

Royal Canadian Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. D. E. J. Hampson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. R. L. Blackmore; P/O. H. D. Brander; Sgt. W. B. Clark.

MISSING.—P/O. E. J. Ames; P/O. W. S. Brown; P/O. W. H. Watt.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. J. R. Pierce; P/O. M. M. Stewart; P/O. S. H. A. Wright.

KILLED ON ACTIVE SERVICE.—Sgt. A. V. Roffey.

Royal New Zealand Air Force

KILLED IN ACTION.—Sgt. E. D. Cannon; Sgt. J. B. Kennedy; Sgt. N. F. Woulden.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. I. M. V. Field; P/O. J. E. M. Steeds.

WOUNDED OR INJURED IN ACTION.—F/O. W. T. Eiby.

MISSING.—Sgt. V. Arthur; Sgt. A. R. Batley; P/O. A. G. Huggett; Sgt. J. K. Ibbotson; Sgt. J. B. Oliver; Sgt. A. R. Reynolds; Sgt. H. T. Sturt.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—P/O. M. P. Angland; P/O. M. M. Campbell; P/O. W. U. A. Hewett.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. L. E. Atkinson; Sgt. C. J. Rudge.

South African Air Force

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Air Sgt. M. V. Fleming.

WOUNDED OR INJURED IN ACTION.—Lt. S. A. Finney.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Cpl. R. Rich.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Lt. R. E. Stanford; Air Sgt. A. Zamek.

Indian Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. R. N. Dastur.

Casualty Communique No. 121.

Royal Air Force

KILLED IN ACTION.—Flt. Sgt. A. B. Giles; Sgt. A. C. Moore; P/O. P. G. Stote; Flt. Sgt. D. Thornton; Flt. Sgt. B. A. Tonks.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. J. L. Angell; Sgt. S. Barton; Sgt. R. C. Blamey; Sgt. E. T. Christie; Sgt. A. R. Cooper; P/O. K. T. Cooper; P/O. J. P. B. Cushion; F/O. J. H. M. Davies, D.F.C.; Sgt. A. Evans; Sgt. W. H. A. Everson; Sgt. H. F. Fordham; P/O. D. S. Fraser; F/O. D. V. Gilmour; Flt. Sgt. L. V. Goode; P/O. G. A. O. Gordon; Sgt. I. E. Griffin; Flt. Sgt. R. M. Hannan; Sgt. S. N. Harvey; Sgt. G. W. T. Jackson; F/O. R. M. P. Jenkyns; Sgt. D. W. Jennings; Sgt. B. S. Jones; Sgt. E. H. King; Sgt. N. J. Lewery; P/O. T. P. Lynch; Sgt. W. F. MacGregor; Flt. Lt. I. P. Magrath; Sgt. R. T. Martin; Sgt. F. Morris; P/O. G. H. S. Pullen; P/O. H. Quilliam; L.A/C. W. G. Sheean; Sgt. D. Slater; Sgt. A. H. Stroud; P/O. A. R. Thomas; Sgt. N. Willingham; Act. Flt. Lt. J. H. Wilson; Sgt. W. C. Wright.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. A. W. Adams; Sgt. A. J. Appleby; Sgt. R. J. Baghurst; Sgt. P. D. Baker; Flt. Sgt. D. G. Barbone; Sgt. G. L. Bentley; Sgt. W. C. K. Bounds; P/O. J. P. N. Britton; Sgt. M. G. Brown; P/O. W. B. Burrows; Sgt. R. P. Carking; Sgt. R. S. C. Craig; Sgt. W. Cross; Sgt. A. C. Cutler; Sgt. J. S. C. Edge; Sgt. L. H. Ellis; Sgt. P. J. W. Ennis; P/O. L. F. Evans; Sgt. E. R. Foster; Sgt. A. C. Frost; P/O. F. K. Gill; F/O. G. E. Goodman, D.F.C.; P/O. J. M. Graham; Sgt. R. S. Green; Sgt. N. L. Harding; Flt. Sgt. A. A. Horn; Sgt. G. T. Hunt; Flt. Sgt. C. J. Jolin; Sgt. E. R. Ingram; Sgt. D. A. Johnson; Sgt. G. T. Jones; Sgt. K. I. Jones; Sgt. J. G. C. Keeble; Sgt. E. G. King; Sgt. G. K. Kircher; P/O. T. P. McGerty; L.A/C. A. E. McQuitty; Flt. Sgt. H. Mainey; Sgt. R. M. Milligan; Sgt. R. G. L. Morley; Sgt. L. A. Morris; Sgt. D. M. Napier; Sgt. A. W. Petherick; Sgt. A. L. Roberts; Sgt. M. G. Robertson; Sgt. G. W. Robson; Sgt. L. E. S. Salt; Act. Sqn. Ldr. W. T. C. Seale; Sgt F. B. Tipper; Sgt. R. J. Turner; Flt. Sgt. R. E. Walls; Sgt H. Ward; P/O. H. H. Wells; Sgt. L. Whittle; Sgt. A. N. P. Witting.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW REPORTED KILLED IN ACTION.—P/O. A. J. W. Froggatt; Sgt. J. D. M. Prentice, Sgt. D. A. Young.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. M. A. Forrest; Sgt. H. Freeman; Sgt. J. B. Hughes; Sgt. R. E. Nicholson; Sgt. D. Sidebottom; Sgt. W. J. C. Thompson.

WOUNDED OR INJURED IN ACTION.—P/O. H. M. Coffin; Act. Sqn. Ldr. B. Finucane, D.S.O., D.F.C.; Sgt. R. Mattison; Sgt. J. D. White; Sgt. F. W. Williamson.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. S. Grabham; Sgt. P. Tyas.

MISSING.—Sgt. J. W. Aston; P/O. M. E. C. Bird; Sgt. K. W. Blyth; Sgt. G. H. Bonner; Sgt. C. Carless; Flt. Sgt. G. J. Cheatley; Sgt. A. K. Cobb; A/C.2 G. C. G. Cross; Sgt. J. G. Crossley; Sgt. F. E. Daking; F/O. K. G. C. Davies; Act. Sqn. Ldr. R. D. Davis; Sgt. A. J. De Cann; Sgt. A. T. Donkin; Sgt. B. P. Dunstan; Flt. Sgt. G. W. Elwell; Sgt. E. G. Green; Sgt. K. W. Heard; Sgt. L. J. Hodson; Sgt. J. Humphries; Sgt. A. Jackson; Flt. Sgt. F. McGregor; Sgt. D. McLellan; Sgt. F. Margerson; P/O. J. R. V. Marshall; Flt. Sgt. G. M. J. Mayes; Act. Flt. Lt. W. H. Norledge; Flt. Sgt. N. N. Palmer; Flt. Lt. A. B. Parker; Sgt. T. Parkinson; P/O. M. L. Pearson; Sgt. E. W. Phillips; P/O. A. Pickles; P/O. D. E. Pike; Sgt. K. J. Powell; P/O. K. T. Reeves; P/O. E. Sitarman; Sgt. D. T. Smith; Sgt. D. W. Smith; Sortwell; Sgt. J. R. Strathdee; Flt. Lt. M. O. Sgt. G. S. Smith; P/O. P. P. Smith; Sgt. F. W. Weizmann; Sgt. R. C. Wentworth-Hyde; Sgt. A. J. Wheeler.

KILLED ON ACTIVE SERVICE.—Sgt. A. E. Adlam; Sgt. A. B. Anderson; Act. Flt. Lt. C. A. W. Bodie, D.F.C.; L.A/C. W. E. Carter; Sgt. E. T. A. Cartwright; L.A/C. P. Cockburn; Act. Wing Cdr. A. N. Cole; L.A/C. L. B. S. Falkiner; Sgt. A. W. Ford; L.A/C. J. A. Fox; P/O. V. W. Gunther; Sgt. J. G. Hardie; P/O. W. K. Johnson; A/C.2 S. J. Lloyd; P/O. A. J. McDonnell; Sgt. W. Mance; Sgt. G. S. Metcalf; Sgt. L. G. J. Misen; F/O. G. E. Musgrove; L.A/C. F. Poole; Sgt. D. E. Prior; Sgt. A. Robson; Sgt. A. C. E. Rogers; Act. Flt. Lt. G. L. Roscoe; L.A/C. Cadet W. R. Shaw; P/O. D. P. Smith; Sgt. J. S. Taylor; Sgt. J. A. Webb; L.A/C. R. J. Whyte.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—L.A/C. W. Anderson; Sgt. G. N. Arnold; L.A/C. E. Blackburn; L.A/C. A. R. Boyle; A/C.2 W. R. Cooper; Sgt. T. Hackston; Act. P/O. D. H. Hobson; P/O. G. W. Payton; A/C.2 E. T. Rees; L.A/C. A. L. S. Tennent; Sgt. H. Varley; A/C.1 C. G. Watson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Cpl. C. W. Gerrard; Flt. Sgt. N. Gray, D.F.M.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Flt. Sgt. J. Boyd; Sgt. E. J. Doyle; Sgt. G. R. Ferguson; L.A/C. T. W. Hardy; Sgt. S. R. J. Harper; Sgt. K. L. Morrell; Sgt. A. J. C. Pegrum; L.A/C. R. G. Rodwell; Sgt. S. J. G. Rutherford.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. D. B. Atkinson; Act. Flt. Lt. V. A. Nicholls.

DIED ON ACTIVE SERVICE.—Flt. Sgt. T. S. Ancott; A/C.2 W. E. Brown; Sgt. T. E. Carr; Flt. Lt. R. K. Coupland; A/C.2 A. R. Davies; A/C.1 W. L. Davies; A/C.2 H. R. W. Dreyler; Sgt. W. E. Elliott; Cpl. H. F. Grills; A/C.2 L. E. Gravett; A/C.2 G. Harper; L.A/C. J. Howe; A/C.1 H. W. Hutchinson; A/C.2 A. J. Joyner; L.A/C. D. F. Mullaney; A/C.2 W. F. Prnce; A/C.2 W. J. Wilding; A/C.2 E. C. Wratten; A/C.2 A. J. Zolkowski.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Flt. Sgt. C. J. Bourner.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—A/CW.2 A. Edmundson; A/CW.2 M. J. Guy.

Royal Australian Air Force

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—P/O. D. S. Jefferies.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. H. Stubbs.

MISSING.—Sgt. F. G. Harper.

KILLED ON ACTIVE SERVICE.—Sgt. A. J. Foote; Sgt. S. W. Greenwood; Flt. Lt. A. R. Parker.

Royal Canadian Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. W. M. G. Dunham; Sgt. W. Owen; Flt. Sgt. T. E. Parker.

MISSING.—Flt. Sgt. W. D. Hagyard; P/O. J. R. McCulloch; Sgt. J. H. G. Matthews; P/O. M. N. Powell; Sgt. C. B. Rourke.

KILLED ON ACTIVE SERVICE.—Sgt. L. J. R. Bechard; Sgt. R. O. Colquhoun; Sgt. E. G. Jenner; Sgt. H. E. Jowett; Sgt. R. H. Lean; P/O. D. J. Richardson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. L. S. Barker; P/O. J. M. Taylor.

Royal New Zealand Air Force

KILLED IN ACTION.—Sgt. E. B. Hewitt; Sgt. J. Macpherson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. B. W. Feeley; Sgt. R. W. Taylor.

MISSING.—Sgt. A. M. H. Fleming; Sgt. W. A. Moodie.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. G. M. Goldfinch.

South African Air Force

MISSING.—2/Lt. A. G. Jamieson.

Indian Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. G. A. Samuel.

Malayan Voluntary Air Force

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Flt. Sgt. H. E. Cleaverley; Sgt. V. W. Trevethan.

F/O. K. Campbell who has been posthumously awarded the Victoria Cross. The official citation appears on page 299.

AVIATION